



MP MASTER



MA32051

1211.6/IN 6-8

MODELS 481L and 481L-1

INSTRUCTION MANUAL

The Complete Service Manual for this Instrument consists of the following pieces of literature.

1211.6 IN 23	Installation and Wiring
1211.6 RL 1	Replacement Parts
	Schematics
	Wiring Diagram
	Parts Location on PCB
	Electrical Parts List
	Board Adjustments

PRINTED CIRCUIT BOARD ADJUSTMENTS

Oscillator Frequency and SCR Firing

Proceed as follows.

1. Insert a piece of tape or a piece of insulating paper between the relay contacts that switch on I1. This disables the time proportioning action.
2. Turn the slug of the Oscillator Coil L1 until it is flush with the top of its coil.
3. Turn R2 to mid-position.
4. Turn the RESET control C1 to mid-position.
5. Adjust the setpoint pointer to coincide with the temperature pointer.
6. Connect the voltmeter between the cathode of D1 and ground with the negative probe to ground.
7. Turn power on to the controller.
8. With a suitable insulated alignment screwdriver turn the slug of the oscillator coil L1 until the voltmeter indicates 4 Vdc.
9. Adjust Relay Differential Adjustment R11 until relay just energizes and red (left) pilot light turns on.

Relay Differential Adjustment

Deadband Adjustment R2 on the printed circuit board determines the operating differential of relay K1. R2 is factory set to require 0.006 inch motion of the green setpoint pointer to cause action to change from on to off. Turn R2 CW to widen the differential; turn R2 CCW to narrow the differential. Too narrow a differential (less than 0.015 inch motion of the relay) may cause relay chatter.

Remove the tape or insulating paper from between the relay contacts. Carefully trim Oscillator Coil L1 until equal ON-OFF time is obtained with the two pointers at coincidence.

Electrical Parts on Board Assemblies A-9061 (481L) and A-7563 (481L-1)

Symbol	Part Number	Description
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CAPACITORS

C2,4,7	39-415	250pF, 20%, 500 WVDC
C3	39-139	82pF, 5%, 600 WVDC
C5,12	39-417	0.01uF, GMV, 1000 WVDC
C6	39-153	50uF, 50% -10%, 50 WVDC
C9	39-196	0.22uF, 20%, 100 WVDC
C10	39-262	5pF, 10%, 500 WVDC
C11	CYZR-680	32uF, 50% -10%, 40 WVDC
C8	39-153	50uF, 50% -10%, 50 WVDC (481L)

DIODES

D1	37-093	12V Zener, 10%, 400mV
D2,3	EYZP-384	80 P.I.V., 100mA, Silicon
D4	EYZP-384	80 P.I.V., 100mA, Silicon (481L)
D4,6	37-066	400 P.I.V., 750mA, Silicon (481L-1)
D5	37-148	1/2V minimum voltage drop at 250mA

INDUCTANCES

L1	41-130	2.7uH max., 1.2uH min.
L2,3	41-136	RF Choke, 43uH, 10%

TRANSISTORS

Q1	EYZP-623	2N4126
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RESISTORS

Resistors are 10% tolerance, 1/2W, unless stated otherwise.

R1	CYZR-170-4	6.8k
R2	29-256	Deadband Adjustment, 250 ohms, 20%
R3	CYZR-170-1	22k
R4	40-077	270 ohms
R5	CYZR-133-2	1.5k
R6	CYZR-170-47	330 ohms
R7	40-014	150 ohms
R8	CYZR-170-11	180k
R9	CYZR-170-9	68k
R10	CYZR-326-44	10k, 1%, 3W (481L-1)
R11	29-256	Relay Differential Adjustment, 250 ohms, 20%
R12	CYZR-170-32	470 ohms

SILICON CONTROLLED RECTIFIERS

SCR1	37-149	C6B (481L-1)
SCR1	37-094	C6F (481L)

Electrical Parts Not on Board Assemblies

Models 481L and 481L-1 Electrical Parts List

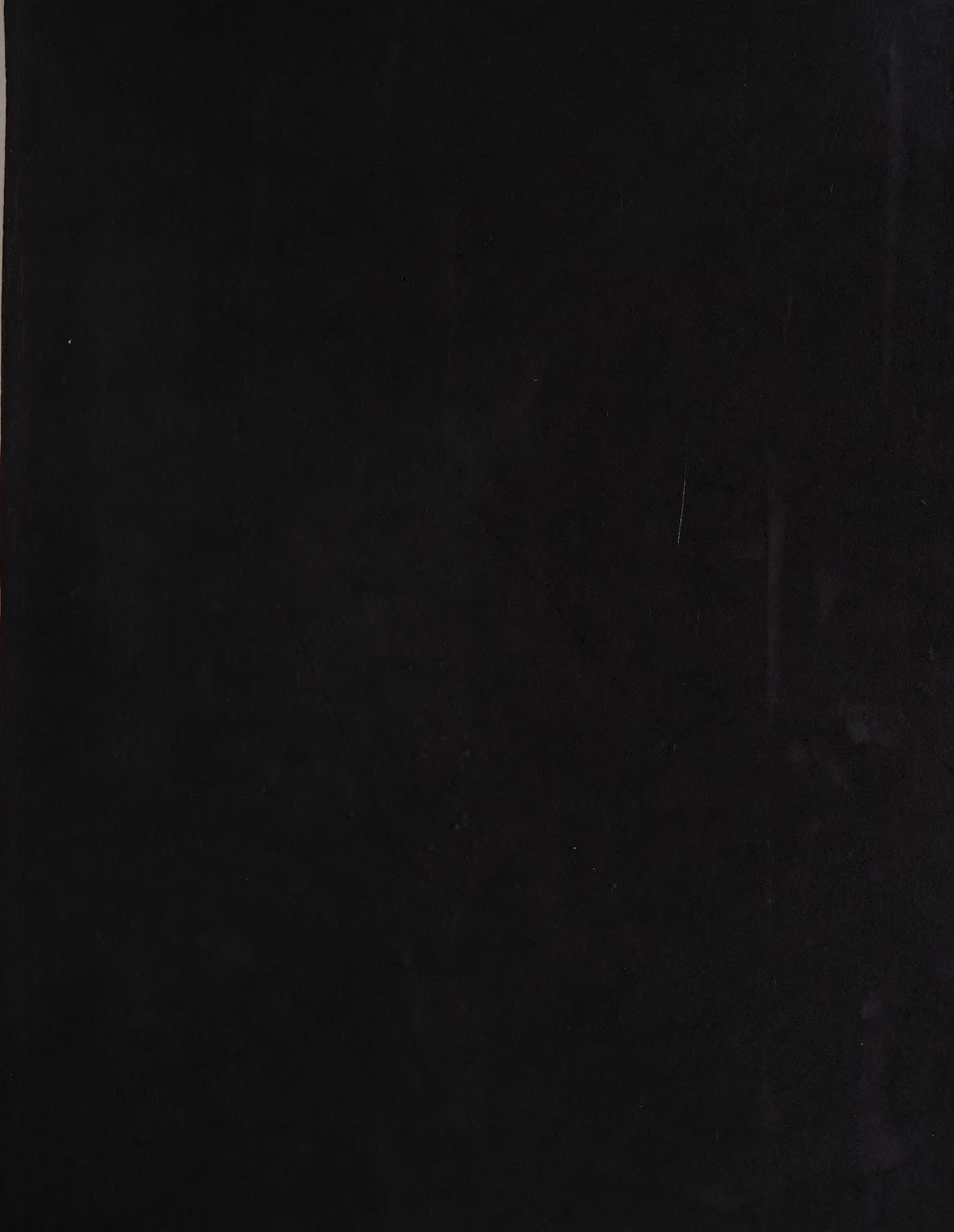
Symbol	Part Number	Description
CAPACITORS		
C1	39-193-1	RESET Control, 2-20pF, 1.8/2.0pF min., 20/25pF max.
C8	39-196	0.22uF, 20%, 100 WVDC (481L-1)
LAMP		
I1	36-034	14V Incandescent (0.12mA max.).
RELAY		
K1	A-5521	325 ohm coil (481L)
K1	A-7554	4000 ohm coil, pull-in at 8-9mAdc (481L-1)
TRANSFORMER		
T1	30-142	Power (481L)
T1	30-194	Power (481L-1)
SWITCH		
S1	32-164	RESET Pushbutton, SPST

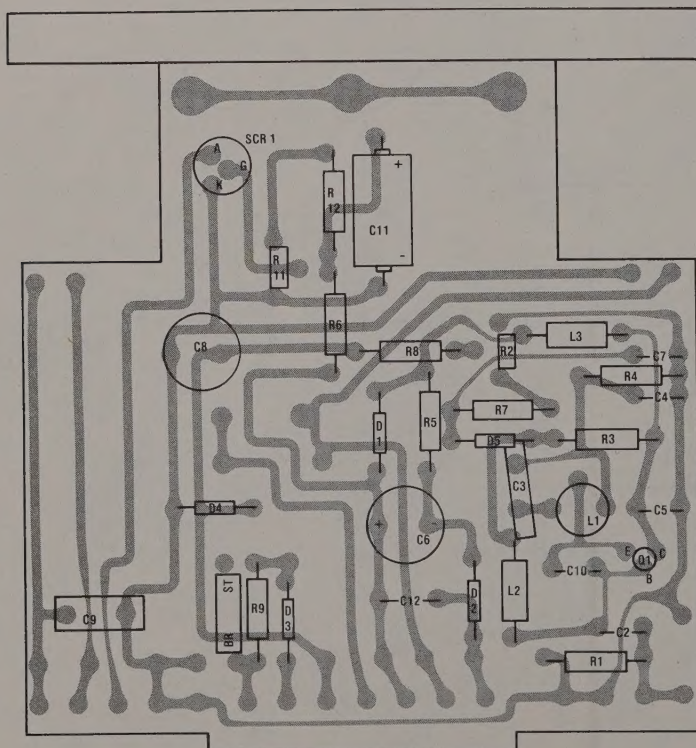
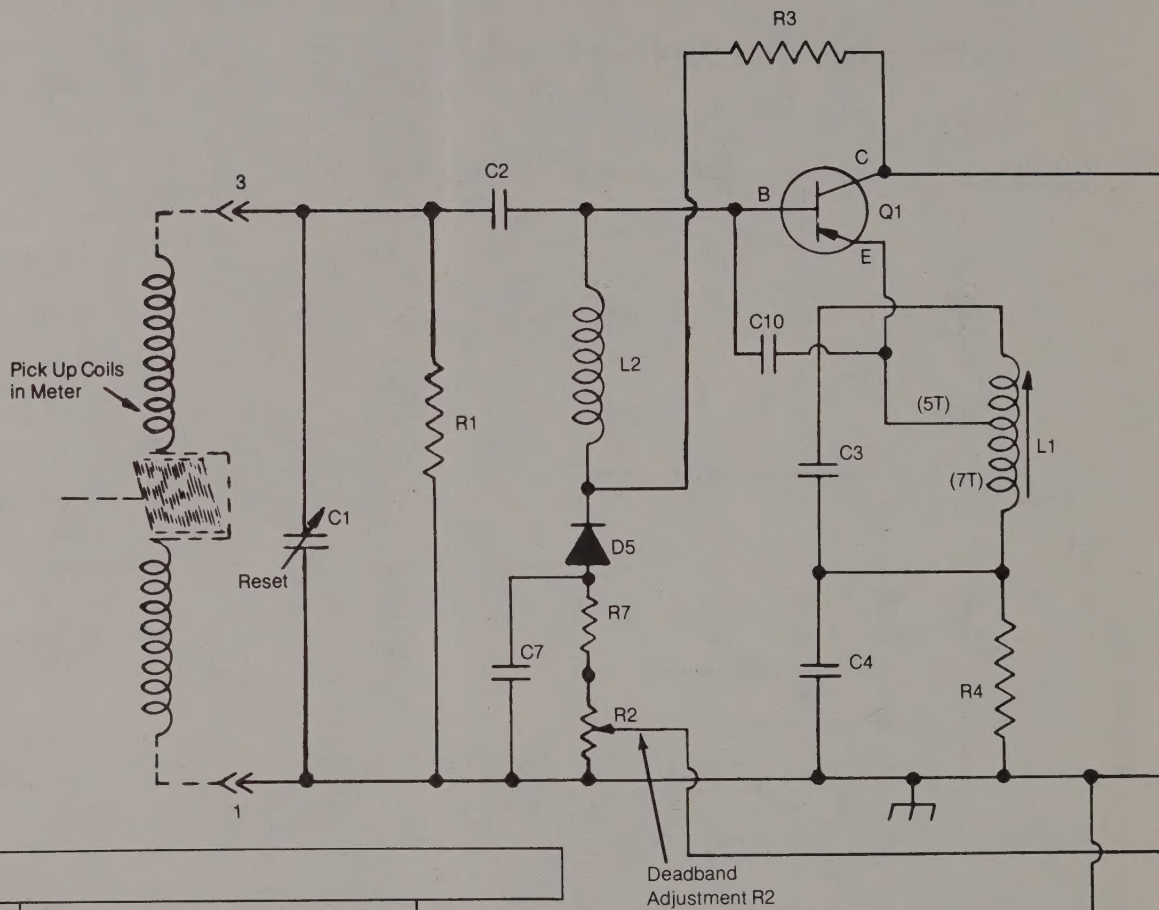
Barber-Colman Company
INDUSTRIAL INSTRUMENTS DIVISION

1300 Rock Street, Rockford, Illinois, U.S.A., 61101

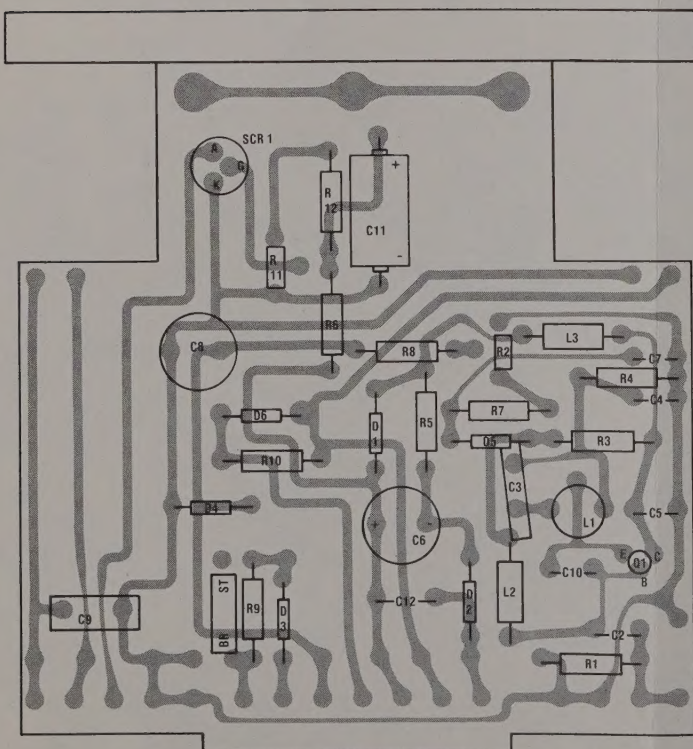
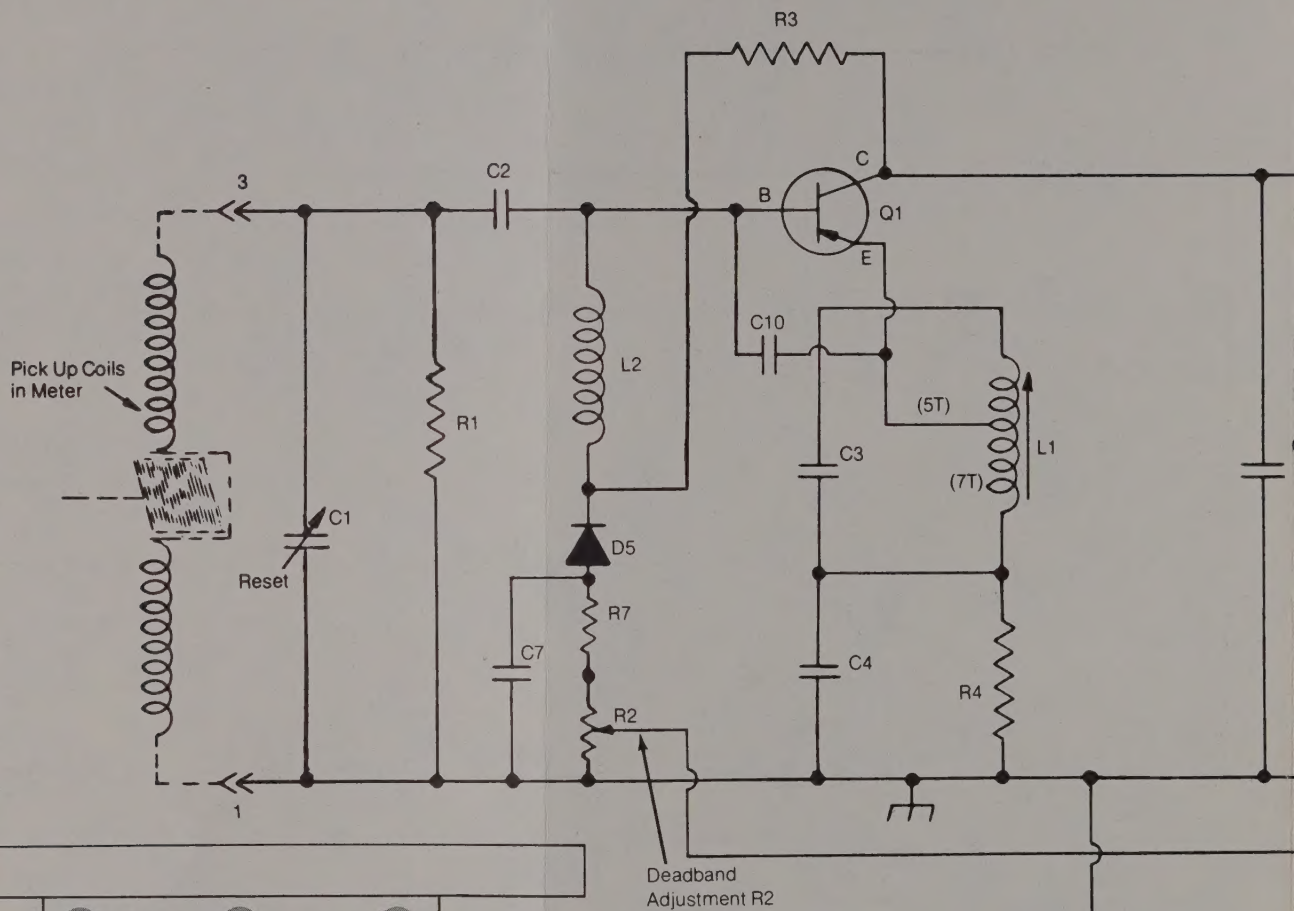
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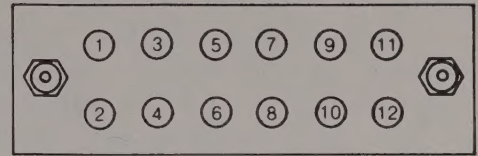
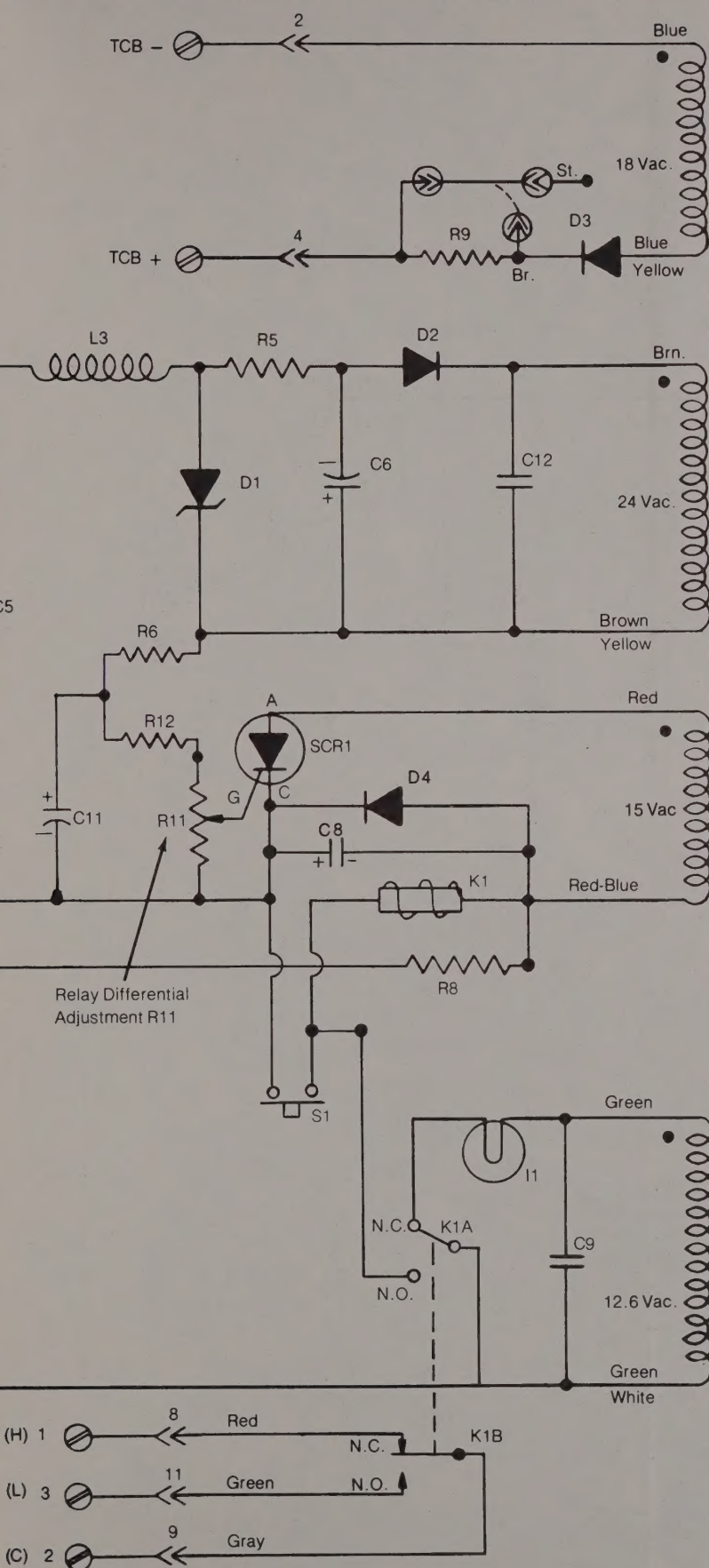




Board Assembly A-9061, Parts Location, Model 481L



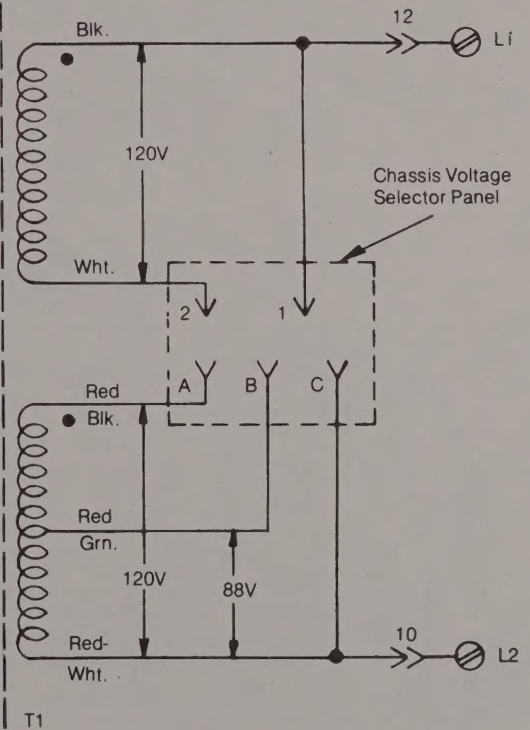
Board Assembly A-7563, Parts Location, Model 481L-1



Rear View Of Chassis Plug

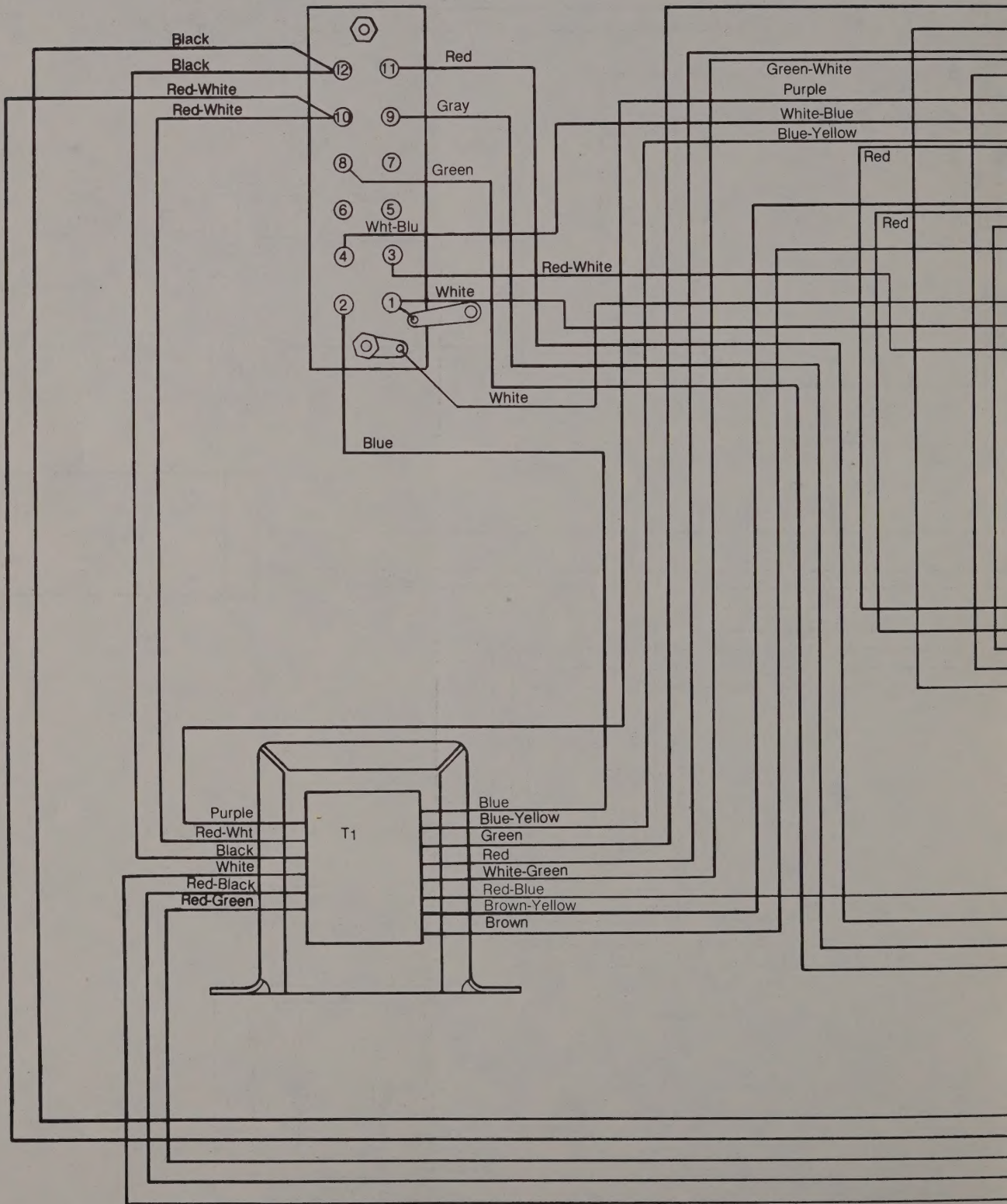
NOTES:

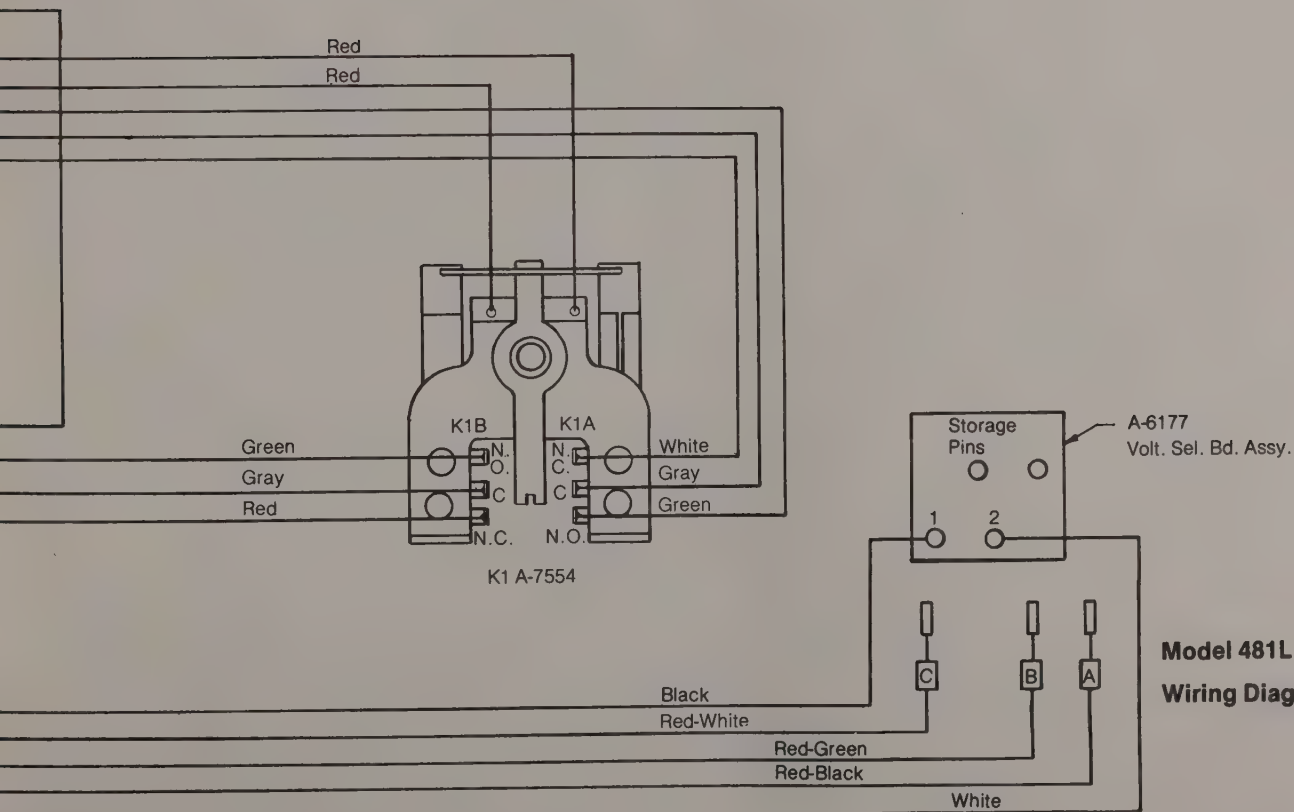
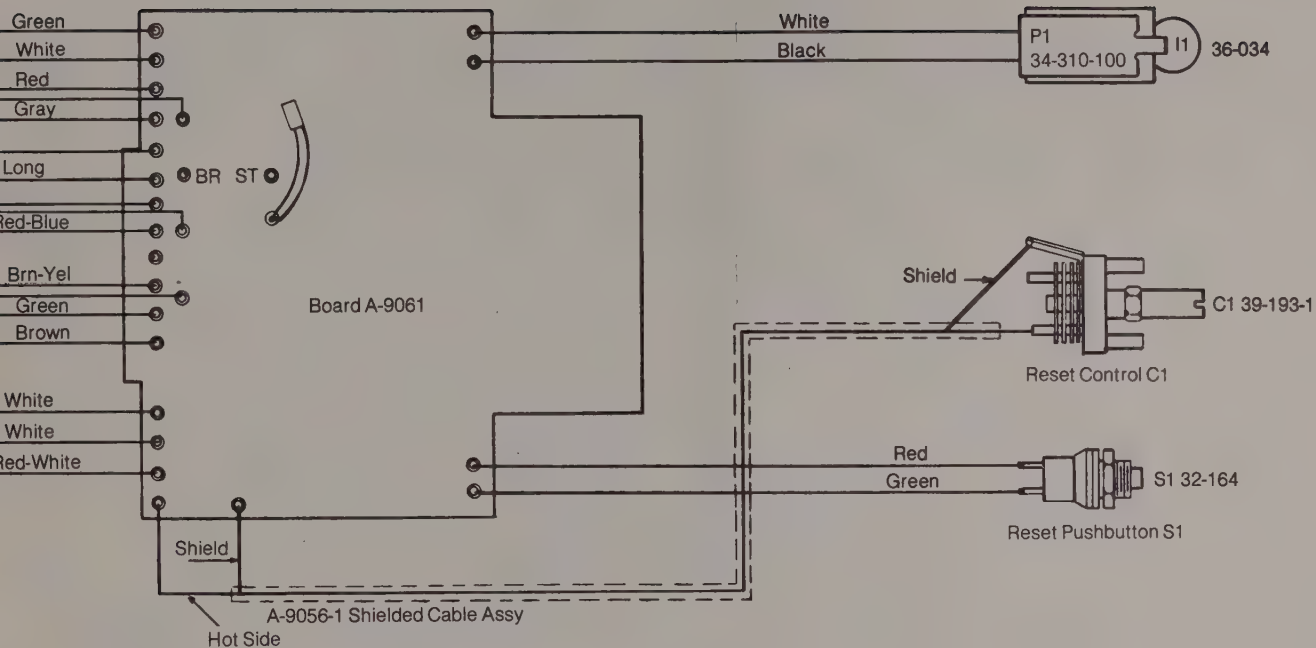
- ⊗ Indicates Screw Terminal Of Housing.
- Indicates Circuit Connections At Chassis Plug.
- ⊗⊗ Indicates Shorting Connection.
- Indicates Mating Of Chassis Plug With Female Receptacle In Housing.



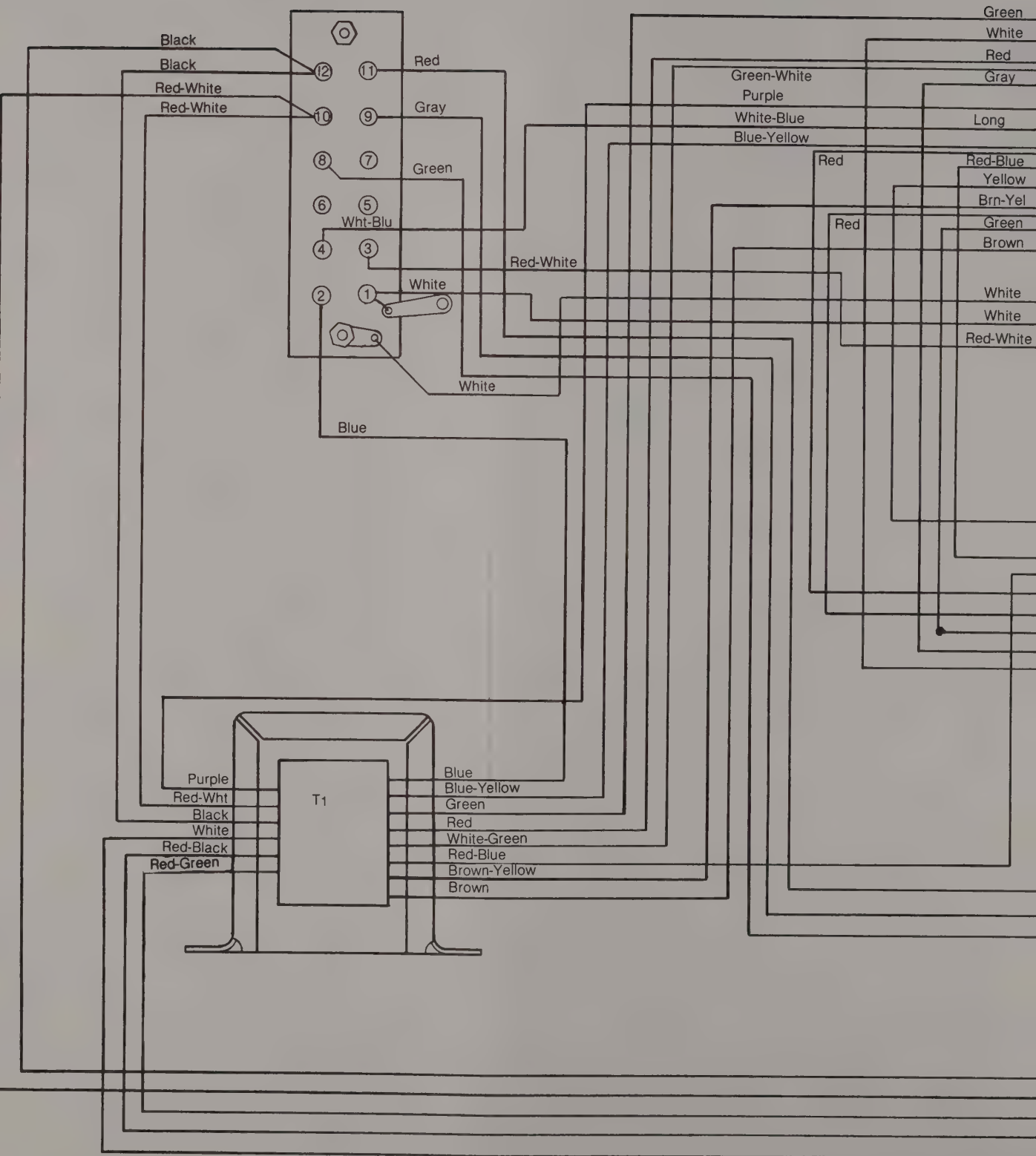
- 120 Vac operation:
connect 1 to A and 2 to C.
- 208 Vac operation:
connect 2 to B.
- 240 Vac operation:
connect 2 to A.

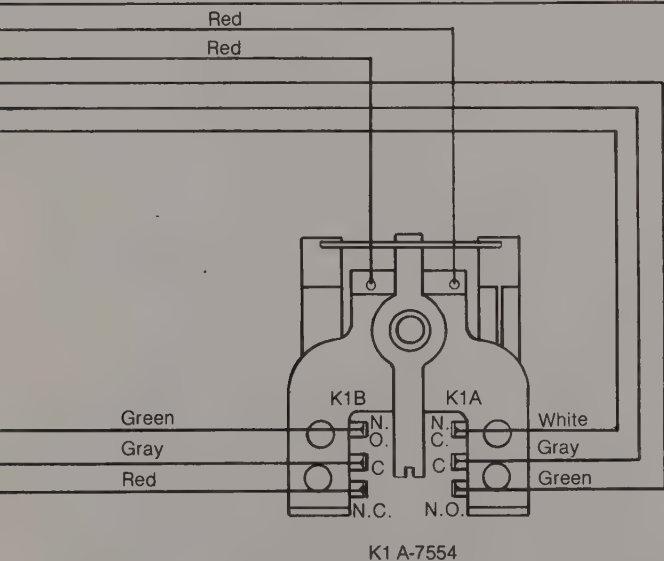
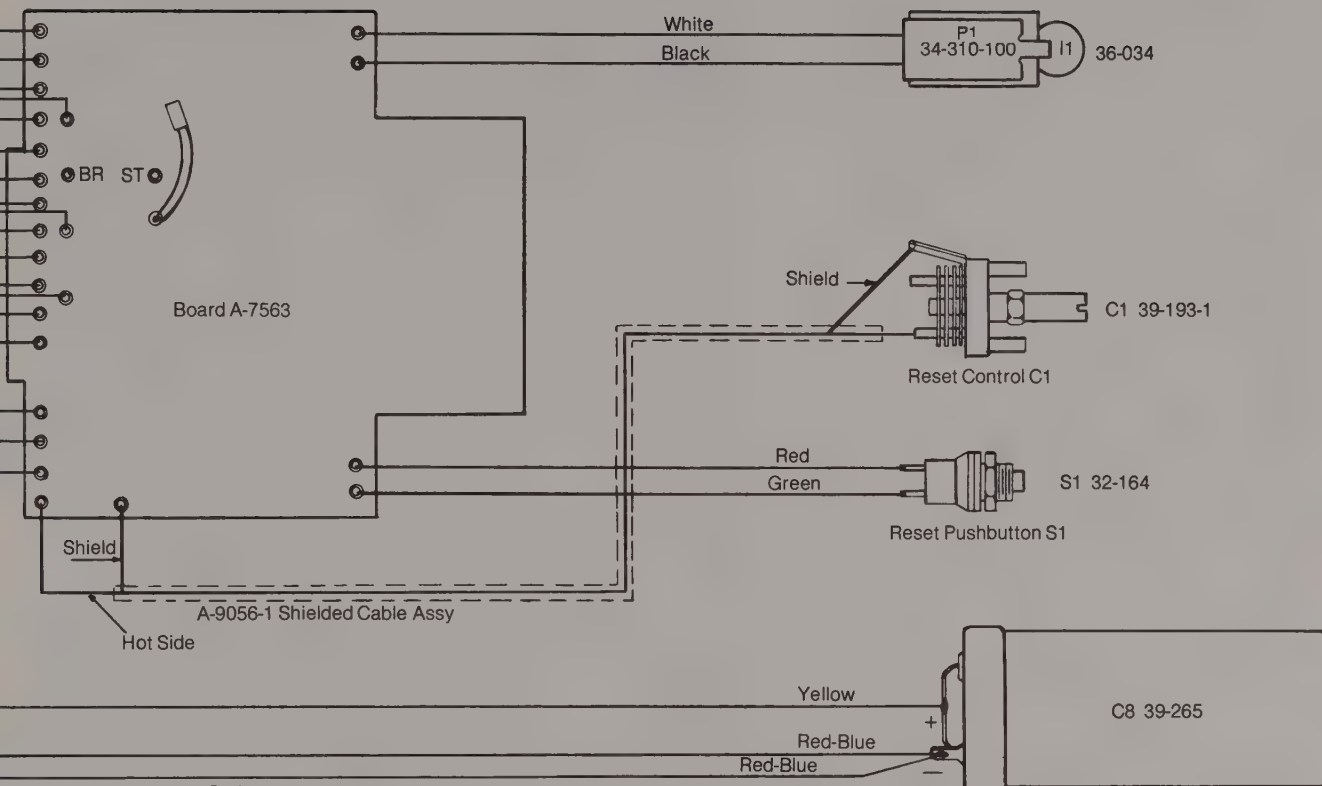
Model 481L-1 Schematic



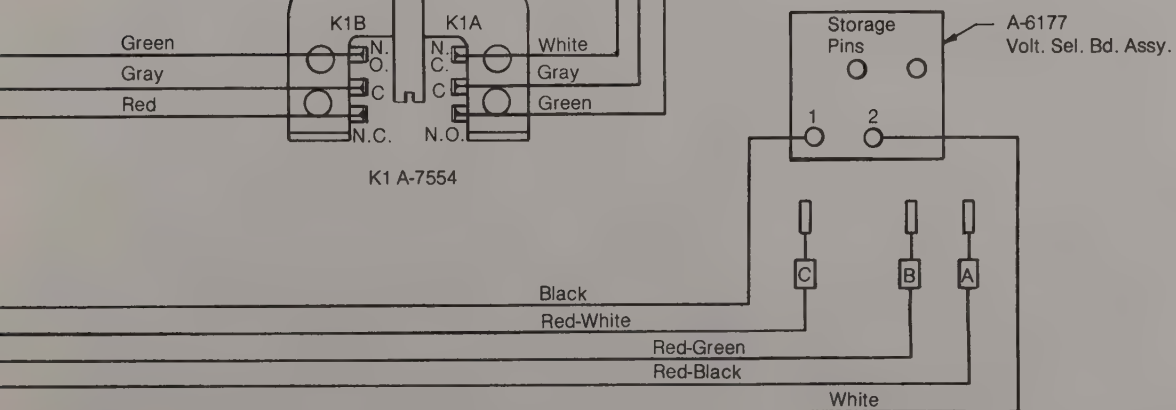


**Model 481L
Wiring Diagram**





Model 481L-1 Wiring Diagram



SERIES 470 INDICATING MILLIVOLTMETER CONTROLLERS

1. AFTER UNPACKING

This instrument has been manufactured carefully, inspected, and packed at the factory. Check the contents of the shipping container against the packing slip. If the equipment is damaged in transit, report the extent of the damage to the carrier immediately. Repack in the original box until ready for installation. Any instructions given on tags attached to the instrument should be followed carefully and then the tags should be removed. Handle with care.

2. MOUNTING

Locate the instrument to avoid excessive dust or oil accumulations, and moisture. The ambient temperature should be within 40°F to 130°F. Avoid furnace walls and other sources of radiant heat.

3. POWER WIRING

Power consumption is 9 VA at 120, 208, or 240 Vac, 50 or 60 Hz. Instrument is wired for 240 Vac, 50 or 60 Hz, when shipped. For 120 Vac or 208 Vac select voltage pin connections on the side of the plug-in control chassis. Do not ground the G terminal to a neutral a-c line. Ground only to an adequate ground.

Install an 1/8 ampere slow-blow fuse in the power line of the instrument.

4. INPUT WIRING

Do not place power wiring and thermocouple wiring in the same conduit or wiring trough. The wires from several thermocouples may be in the same conduit or wiring trough.

If shielded thermocouple leads are used, the shields should be insulated electrically and terminated at one location, preferably the housing ground of the Series 470.

5. ADJUSTABLE LINE COMPENSATOR

All 470 Series Controllers are shipped with an Adjustable Line Compensator on the rear panel within the lower housing compartment. 0–15 ohm Compensators are standard, and others are optional.

ADJUST THE LINE COMPENSATING RESISTOR TO EQUAL THE DIFFERENCE IN RESISTANCE BETWEEN THE LEADWIRE RESISTANCE AND THE MAXIMUM RESISTANCE OF THE ADJUSTABLE LINE COMPENSATOR.

For example: Leadwire resistance is measured to be 5 ohms. Maximum resistance of the Adjustable Line Compensator is 15 ohms (standard).

Set the Line Compensator for 10 ohms.

For best results, now measure the total resistance across the series resistance of the leadwires and the Line Compensator — it should be exactly 15 ohms.

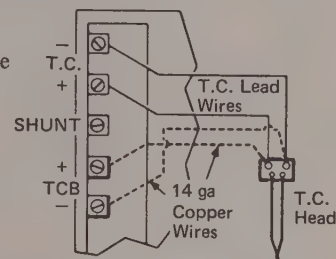
For example: Leadwire resistance is measured to be 17 ohms. Maximum resistance of the Adjustable Line Compensator is 30 ohms. Set the Line Compensator for 13 ohms.

For best results, now measure the total resistance across the series resistance of the leadwires and the Line Compensator — it should be exactly 30 ohms.

6. THERMOCOUPLE BREAK PROTECTION

Figure 5 shows the recommended wiring. This wiring must be done after installation.

Figure 5.
Thermocouple Break
Protection Wiring



With the instrument powered, TCB may cause the meter to read slightly higher than when the meter is unpowered. Correction can be made using the adjusting screw on top of the front cover. With power ON, turn the screw to lower the indicated reading to the same point on the scale obtained when the power was OFF.

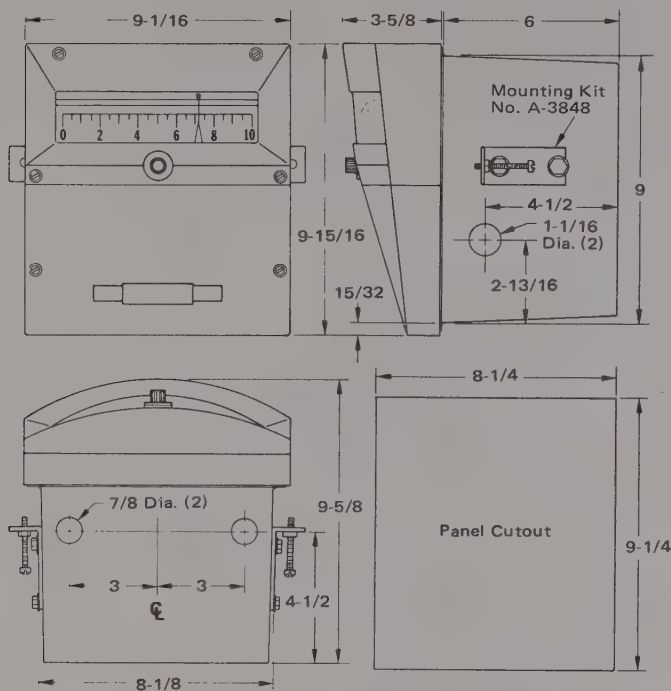
7. LINE COMPENSATION AND TCB ERROR CORRECTION

This applies to models that have Bridge Type TCB (Thermocouple Break Protection).

No external TCB wiring is required for Bridge Type TCB Wiring.

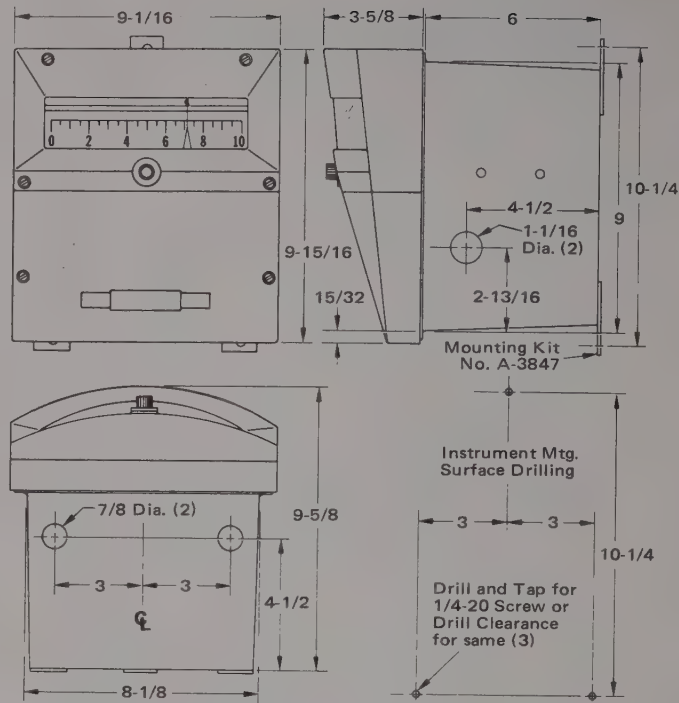
The adjustments are a pushbutton switch and a screwdriver adjustable potentiometer located inside the lower front cover on the left hand terminal strip. The words TCB ADJ are marked between the pushbutton and the adjustable potentiometer. Proceed, as follows, to make the adjustment.

1. Connect the thermocouple and maintain it at a fixed temperature.
2. Turn on power to the Series 470.
3. Depress the pushbutton and record the reading on the meter of the Series 470.
4. Release the pushbutton and record the reading on the meter of the Series 470.
5. If there is no difference between the reading, no adjustment is required. If there is a difference, proceed to Step 6.
6. Adjust the potentiometer with a screwdriver until the meter indicates the reading recorded in Step 3.
7. The proper adjustment is reached when the meter reads the same when the pushbutton is either pressed or released.



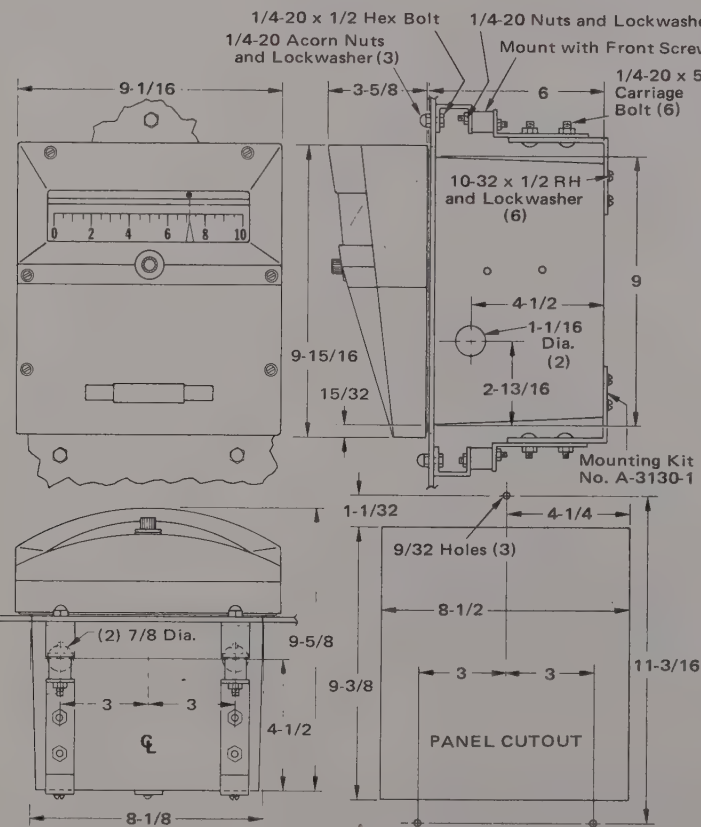
- Note: 1. Maximum Panel Thickness 1-1/4 Inches.
2. Minimum Horizontal Spacing Centers 10 Inches.
3. Minimum Vertical Spacing Centers 10-1/4 Inches.

Figure 1. Flush Rigid Mounting with Kit A-3848



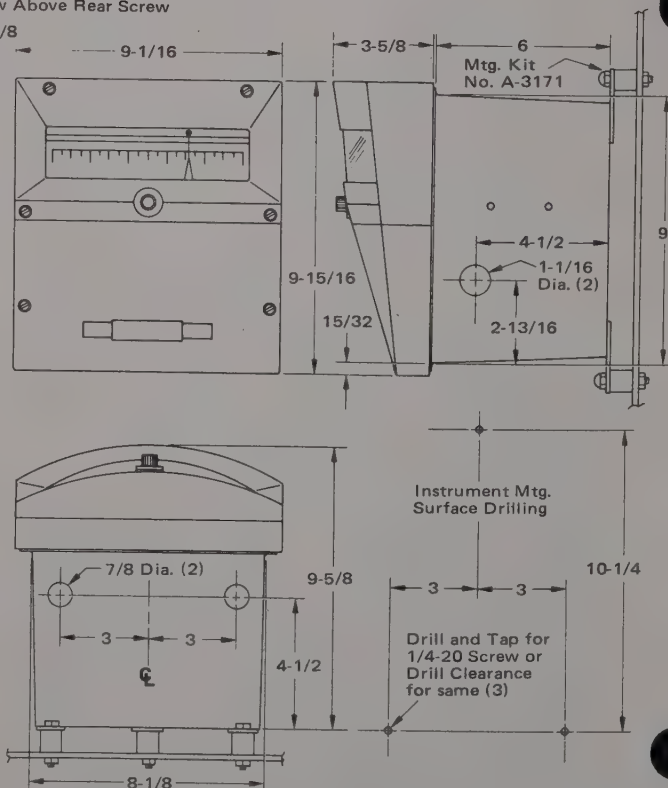
- Note: 1. Minimum Horizontal Spacing Centers 9-1/8 Inches.
2. Minimum Vertical Spacing Centers 11-1/4 Inches.

Figure 2. Surface Rigid Mounting with Kit A-3847



- Note: 1. Minimum Horizontal Spacing Center 9-1/2 Inches.
2. Minimum Vertical Spacing Center, 11 Inches.

Figure 3. Flush Vibration Mounting with Kit A-3130-1



- Note: 1. Minimum Horizontal Spacing Centers 9-1/8 Inches.
2. Minimum Vertical Spacing Centers 11-1/4 Inches.

Figure 4. Surface Vibration Mounting with Kit A-3171

8. OPERATION

8.1 General

Meter should read room temperature — not zero — with thermocouple and thermocouple break wiring disconnected. Adjust the screw on the top of the plastic cover until room temperature is indicated by the red process variable pointer.

The setpoint temperature is selected by adjusting the front panel knob to position the vertical green pointer until it coincides with the desired setpoint on the scale.

Located behind the lower front panel cover are tamper proof controls, usually mounted at the front of the chassis. Not all instruments have the same controls and the same amount of adjustment. Ignore descriptions not applicable to your instrument.

The PROP BAND control varies with the proportional band. Turning the PROP BAND control clockwise will increase the proportional band and counterclockwise will reduce it. Make the adjustments in small increments, starting from a fully clockwise position. The ideal setting is the one which will cause straight line control and yet be at the furthest possible counterclockwise position.

The RESET control is the slotted shaft and is marked RESET. Adjust the RESET control to correct for offset between the indicator pointer and the control setpoint. After the load is thermally stable, the proper adjustment is the one where the meter indicator coincides with the control setpoint.

The CYCLE TIME control varies the switching rate of the output relay. Faster cycle times provide better control of loads with fast response times and little time lag. However, a relatively faster cycle time causes added wear on any internal or external contactors.

8.2 Model 471P-0 Capacitrol® for Two-Position SPDT Control

The Model 471P can actuate solenoid valves, medium sized electrical contactors or relays, and motor controlled valves to control large temperatures. In addition, the Model 471P is applicable to directly controlling up to 1200 VA of heating power to small heating elements.

Reset Control — Adjustable throughout the entire range of the instrument to eliminate offset at control point.

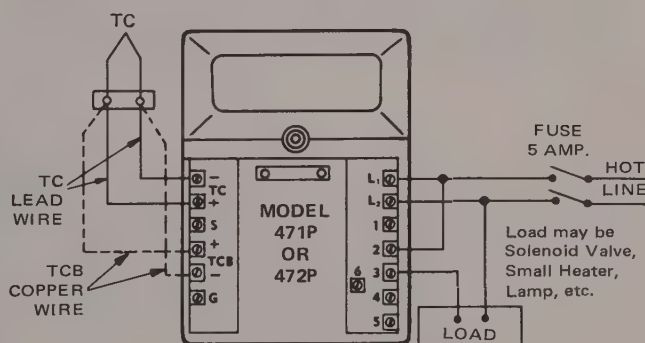
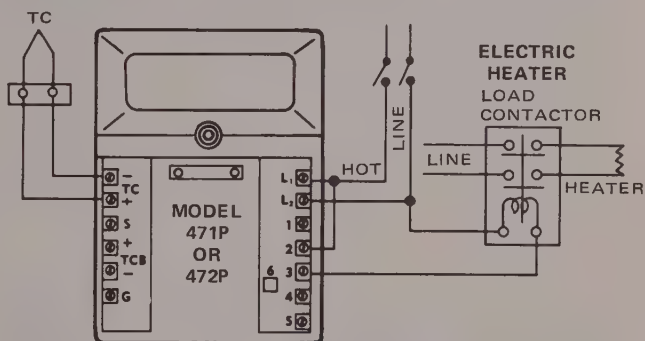
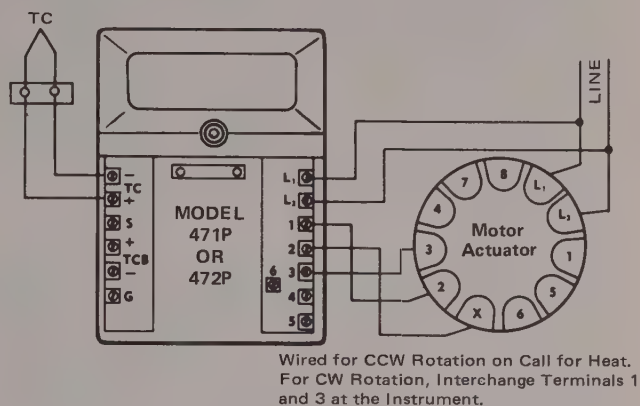
8.3 Model 472P-0 Capacitrol® for Two-Position SPDT Time Proportioning Control

The Model 472P can actuate solenoid valves, medium sized electrical contactors or relays, and motor controlled valves to control large loads. In addition, the Model 472P is applicable to directly controlling up to 600 VA of heating power to small heating elements.

Proportional Band Control — Adjustable from 0.5% to 5% of full scale.

Cycle Time Control — At 5% proportional band the cycle time can be adjusted from 3 to 12 seconds. At 0.5% proportional band the cycle time can be varied from 30 to 120 seconds.

Reset Control — Adjustable throughout the entire range of the instrument to eliminate offset at control point.



Control Wiring

Terminals 1, 2 and 3 are the relay contact connections
Terminal 1 is the normally closed contact
Terminal 2 is the common
Terminal 3 is the normally open contact

471P-0 Relay Switching Output Ratings

Resistive Loads: 10A at 120 Vac; 5A at 240 Vac
Inductive Loads: 5A at 120 Vac; 2.5A at 240 Vac

472P-0 Relay Switching Output Ratings

Resistive Loads: 5A at 120 Vac; 2.5A at 240 Vac
Inductive Loads: 2.5A at 120 Vac; 1.25A at 240 Vac

Figure 6. Model 471P-0 or Model 472P-0 External Wiring

8.4 Series 473 Capacitrol® for Three-Position (Two SPDT Relays) Control with a Single Control Index and a Differential Adjustment of 1/2-5%

A single measuring system with dual action control functions have been combined in these models. The instrument has a single setpoint and a second phantom spaced control point adjustable from 0.5% to 5.0% of scale in reference to the instrument setpoint. These models are designed for those applications which require either two-position control on one point and time-proportioning (Truline) control on the other or simple two-position control on both or Truline on both points with a constant differential between the control points.

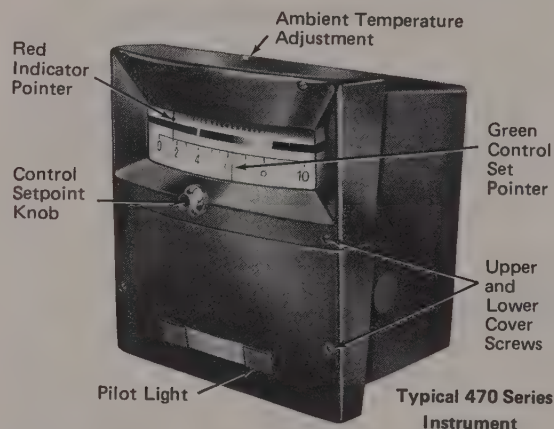
Applications include atmosphere generators, high and low alarm systems, high limit, combination heating and cooling system control, as well as those requiring "high-medium" power control. They will control directly without intermediate devices to activate most solenoid valves, many two-position motor operated valves and small electrical heating elements.

Relay contacts are connected to terminals 1 through 6. The low point relay contacts are always connected to terminals 1, 2, and 3 while the high point relay contacts are connected to terminals 4, 5, and 6. Pilot light action is shown below.

Reset Control — Adjustable throughout the entire range of the instrument to eliminate offset at control point.

Cycle Time Control — Adjustable from 3 to 30 seconds.

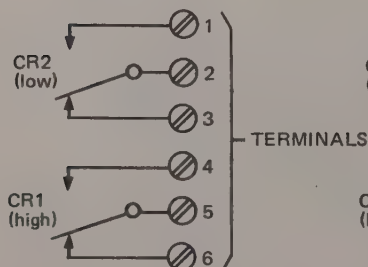
Models	Control Index		Truline Proportioning Action	
	Low Point	High Point	Low Point	High Point
473A	X			
473A-1	X		X	
473A-2	X			X
473A-3	X		X	X
473A-4		X		
473A-5		X	X	
473A-6		X		X
473A-7		X	X	X



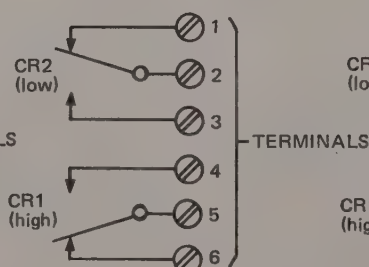
PILOT LIGHT ACTION

Model Number	Below Low Point		Between Points		Above High Point	
	Left	Right	Left	Right	Left	Right
473A	On	On	Off	On	Off	Off
473A-1, -2, -3	On	Off	On	On	Off	On
473A-4	On	On	Off	On	Off	Off
473A-5, -6, -7	On	Off	On	On	Off	On

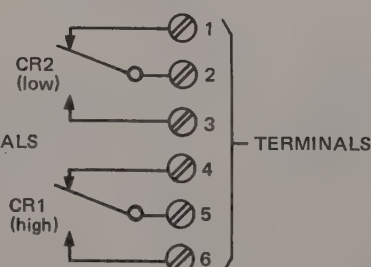
Below Low Point

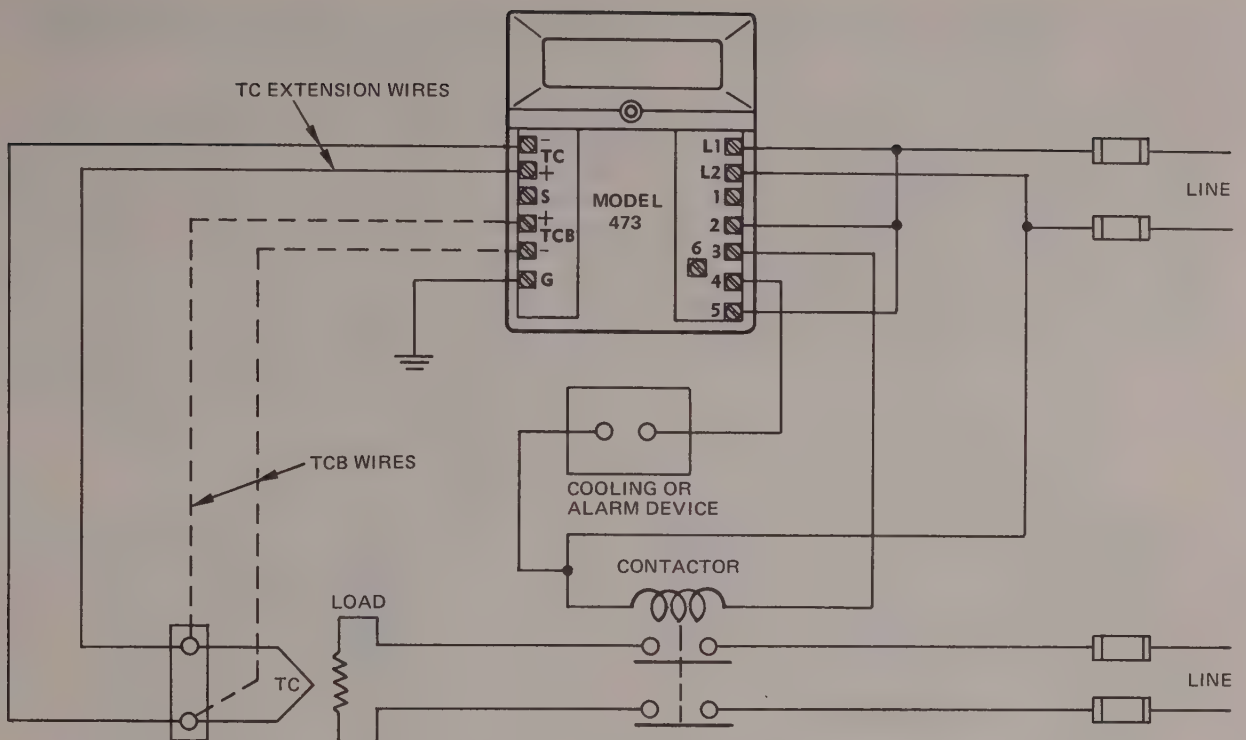


Between Points

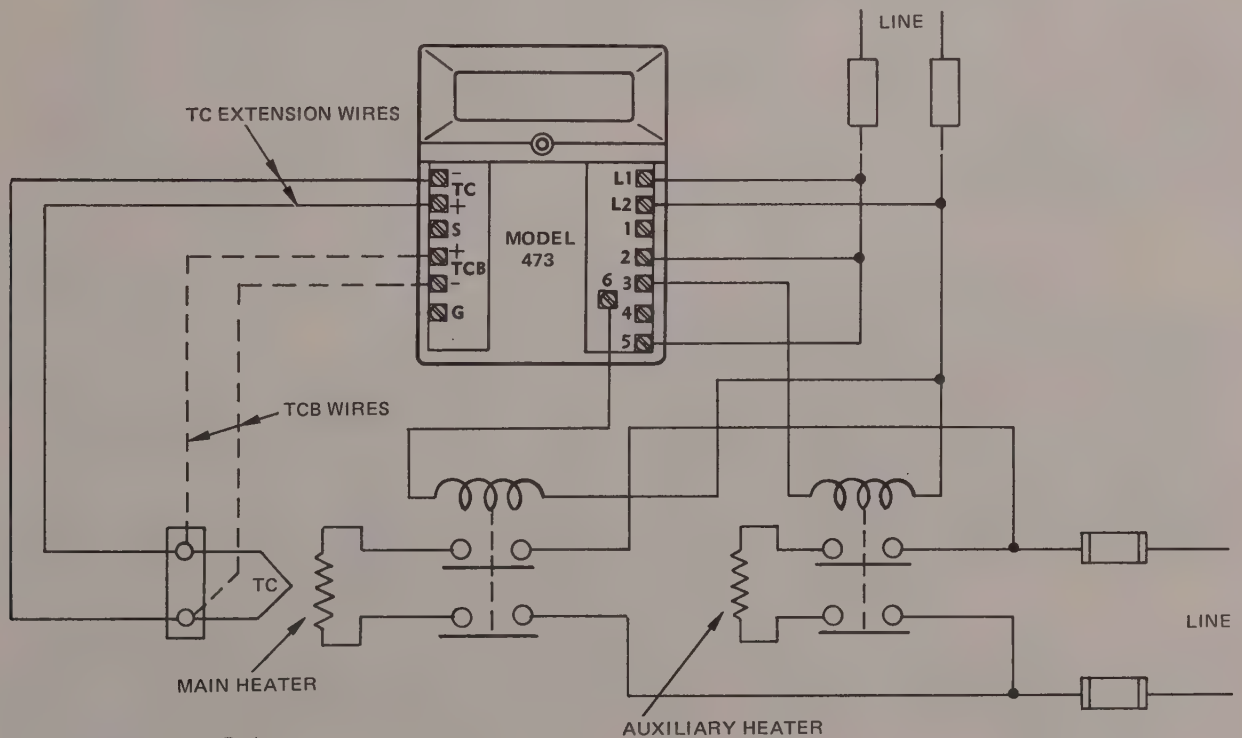


Above High Point





Models 473A, 473A-1, -2, or -3 used for Low Point Control with Cooling or Alarm on High Point



Relay Switching Output Ratings

ON-OFF Control of Resistive Loads: 10A at 120 Vac; 5A at 240 Vac

ON-OFF Control of Inductive Loads: 5A at 120 Vac; 2.5A at 240 Vac

Truline Control of Resistive Loads: 5A at 120 Vac; 2.5A at 240 Vac

Truline Control of Inductive Loads: 2.5A at 120 Vac; 1.25A at 240 Vac

Models 473A-4, -5, -6 or -7 with Auxiliary Electric Heater

Figure 7. Series 473 External Wiring

8.5 Model 475P-0 Capacitrol[®] for Position Proportional Control of Barber-Colman Motor Actuators

The Model 475P actuates a polarized output relay to control a Barber-Colman Motor Actuator that has a built-in 100 ohm feedback potentiometer. The feedback potentiometer whose wiper arm is driven by the shaft of the Motor Actuator provides a proportional position signal to the Model 475P. The input signal is compared with the feedback signal from the Motor Actuator. The resulting unbalanced output drives the Motor Actuator to a position corresponding to the error signal. An intermediate relay

Model 475P and Proportional Motor Actuator wired for CCW rotation to increase input.

For CW rotation to increase input to system interchange terminals 2 with 3 and 7 with 8 on the operator.

CAUTION:

Do not use Motor Operator with built-in transformer.

Control Wiring

Terminals 1, 2 and 3 are the balance relay contact connections of the 475P.

Terminal 2 is the common.

Relay Switching Output Ratings

Contacts rated at 0.5A at 24 Vac.

Model 475P driving a High Torque Motor Actuator through AM-345-0-1 Slave Relay wired so that CCW rotation will increase input to system

AM-345-0-1 is a relay accessory kit which can be mounted on the back plate of the Power Unit, or can be surface mounted. Consists of an AE-347-0-0-1 relay in a housing.

For CW rotation to increase input to system interchange terminals 2 with 3 and 7 with 8 on the operator.

AM-345-0-1 is required when a high torque Motor Actuator (550 to 1300 pound inches) is driven.

Consult factory for other applications.

Error Signal Input — 10 Vac is available for exciting an external 0–100 ohm control slidewire in the Motor Actuator.

Proportional Band Control – Adjustable from 0.5% to 5% of full scale.

Reset Control — Adjustable throughout the entire range of the instrument to eliminate offset at control point.

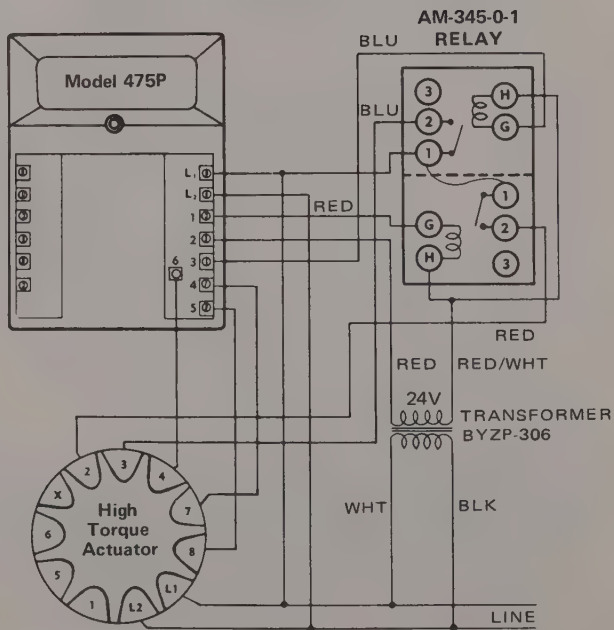
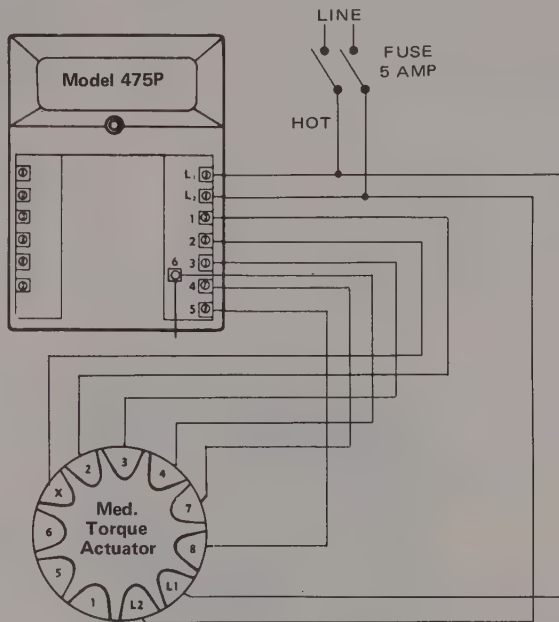


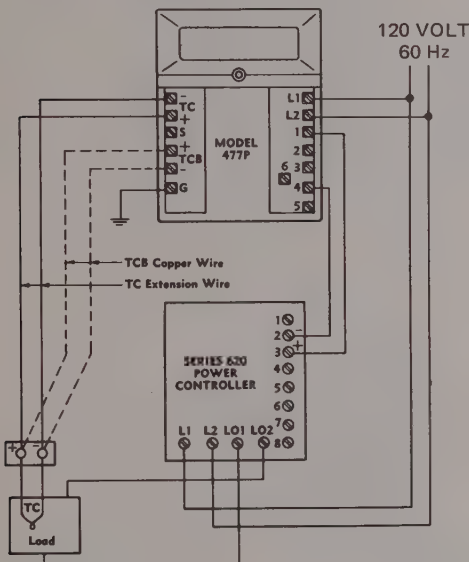
Figure 8. Model 475P-0 External Wiring

8.6 Model 477P Capacitrol® for Proportional Current Control

The Model 477P will drive the Models 655A or 656A Current-to-Position Converters for positioning Barber-Colman Motor Actuators and the Series 620 power controller (3.1 to 90k VA) for control of resistive or transformer coupled loads.

Proportional Band Control — Adjustable from 0.5% to 5% of full scale.

Reset Control — Adjustable throughout the entire range of the instrument to eliminate offset at control point.



Current Output

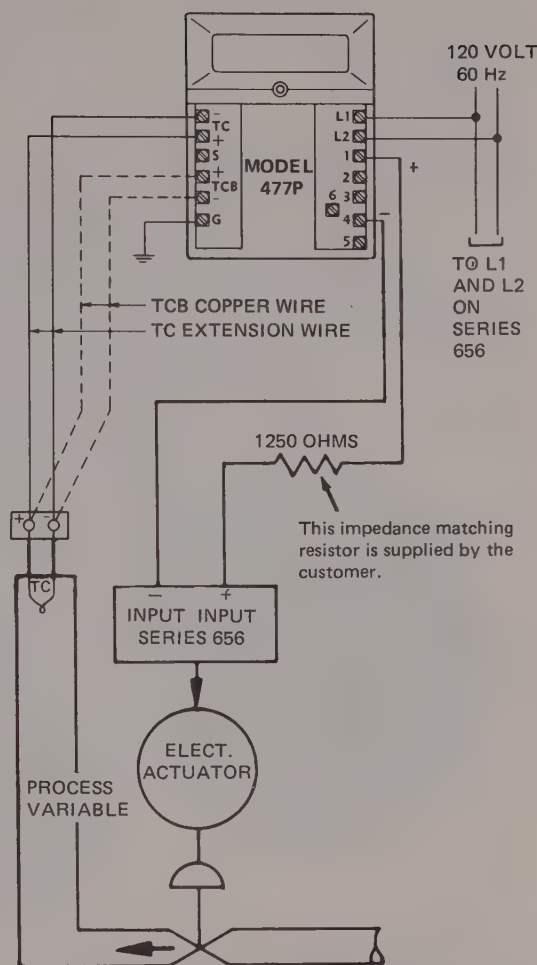
2-12 mAdc on Terminals 1 (+) and 4 (–) into a 1500 ohm load. Short circuit proof.

8.7 Model 480P Capacitrol® for Proportional Control of Barber-Colman Intermediate Controllers Models 683A and 692A

The Model 480P is designed for use with Three Function Intermediate Controllers such as the Barber-Colman current output Model 683A and the switching output Model 692A. The Model 683A will drive either a combination Barber-Colman Pilot Amplifier and Saturable Reactor, the Series 620 Power Controller, or the Series P02R Current-to-Pneumatic Transducer. The Model 692A will drive a Barber-Colman Motor Actuator to a position corresponding to the error signal.

Proportional Band — Fixed at 5% of full scale. Adjustments are normally made in the companion three function controller.

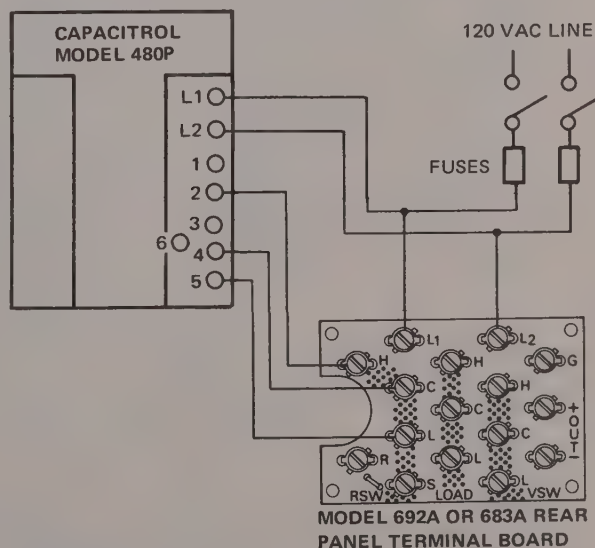
Reset Control — For balancing output to midpoint voltage of 6 Vdc.



Current Output

2-12 mAdc on Terminals 1 (+) and 4 (–) into a 1500 ohm load. Short circuit proof.

Figure 9. Model 477P External Wiring



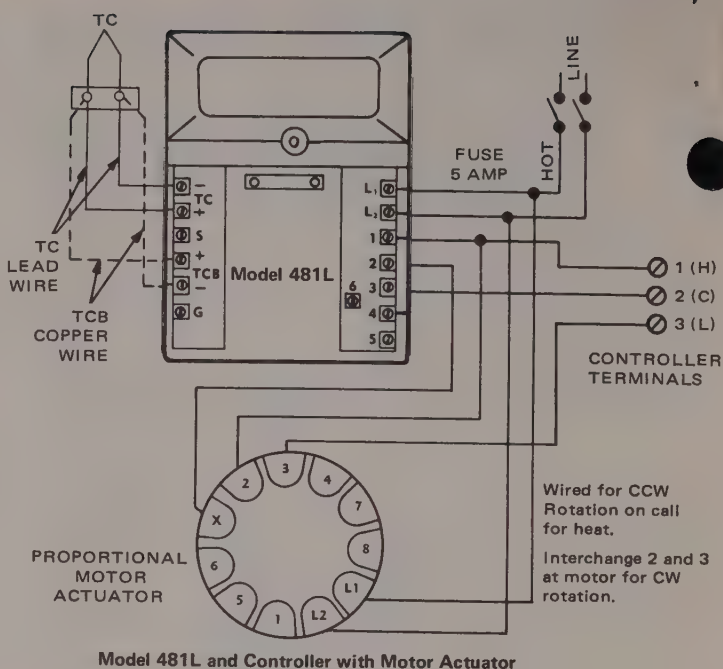
Output Signal
1-11 Vdc on Terminals 2 (+) and 4 (–)

Figure 10. Model 480P External Wiring

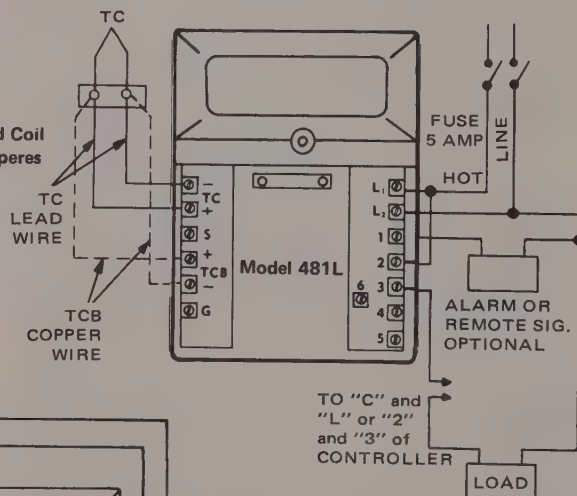
8.8 Models 481L Limitrol® and 481L-1 Limitrol® with Delayed Action, for Shutting Down a Process at Preset High Temperature

Each model has a two position SPDT relay shutdown at preset high temperature. This preset setpoint temperature is selected by turning a screwdriver adjustment which can move a vertical pointer over the entire temperature scale. The screwdriver adjustment is protected by a screw-on cap. Continuous temperature indication is provided even during system shutdown. At the setpoint temperature a front panel lamp lights and a contact is closed to actuate any auxiliary alarm devices. Before power or a fuel supply can be restored, the front panel RESET pushbutton must be pressed to reset the Model 481L. Should the thermocouple input circuit open, a TCB (thermocouple break protection) circuit automatically causes the temperature indicator to drive upscale past the setpoint temperature, deenergizing the internal relay and shutting down the system.

The Model 481L-1 is available for applications where it is important that momentary power failures do not shutdown the process. In the Model 481L-1, 8 to 10 seconds must elapse after a power interruption or after the indicator passes setpoint before the relay is deenergized.



Model 481L with Solenoid Coil or other Load under 5 amperes



Relay Switching Output Ratings

Resistive Loads: 10A at 120 Vac; 5A at 240 Vac

Inductive Loads: 5A at 120 Vac; 2.5A at 240 Vac

120V 60 Hz

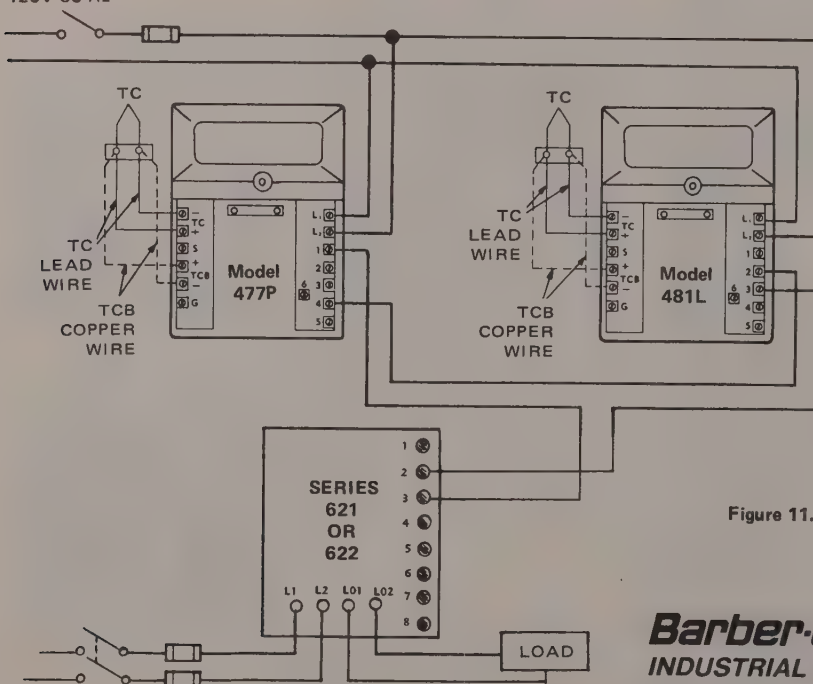


Figure 11. Models 481L and 481L-1 External Wiring

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SERIES 470 AND THE MODELS 480P, 481L, and 481L-1

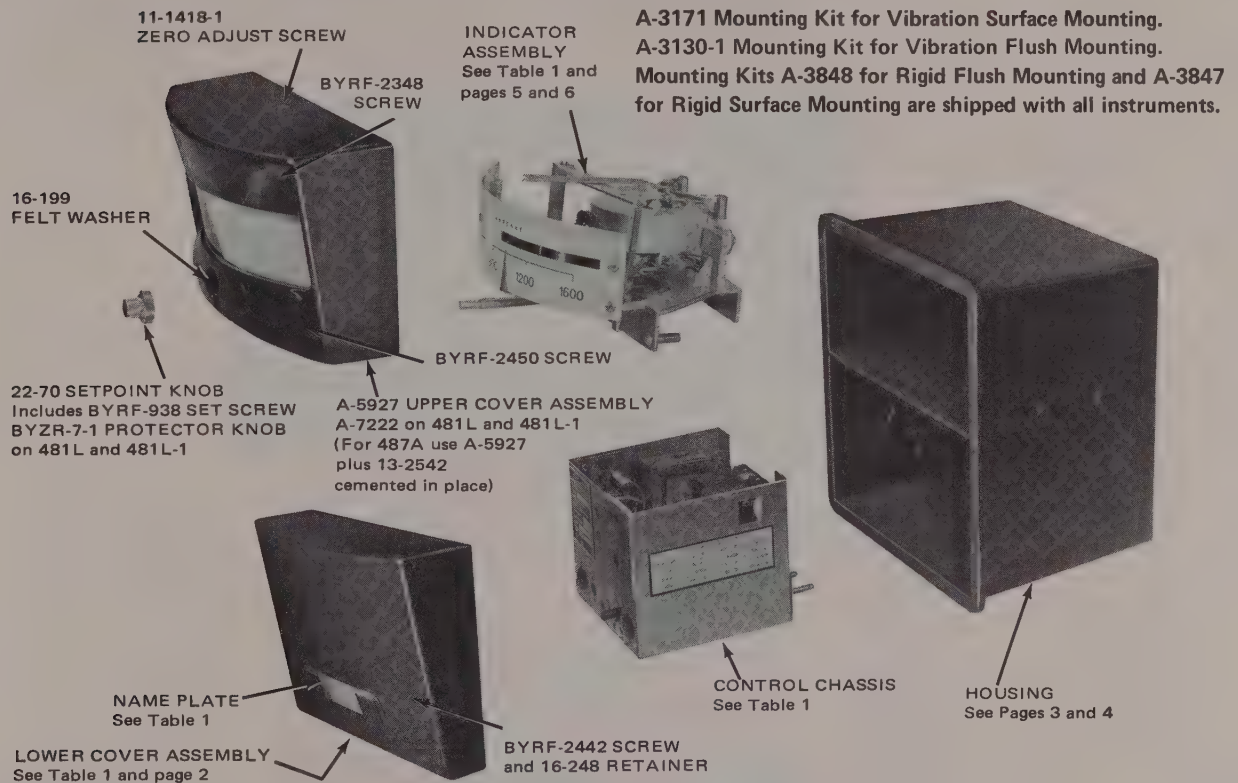
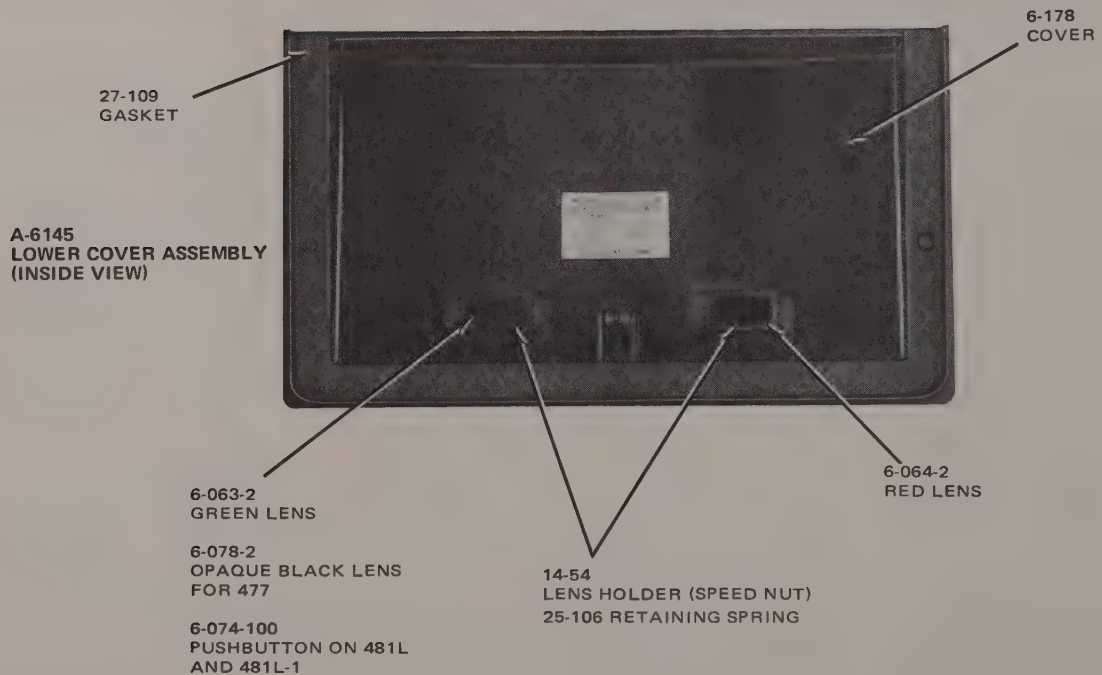
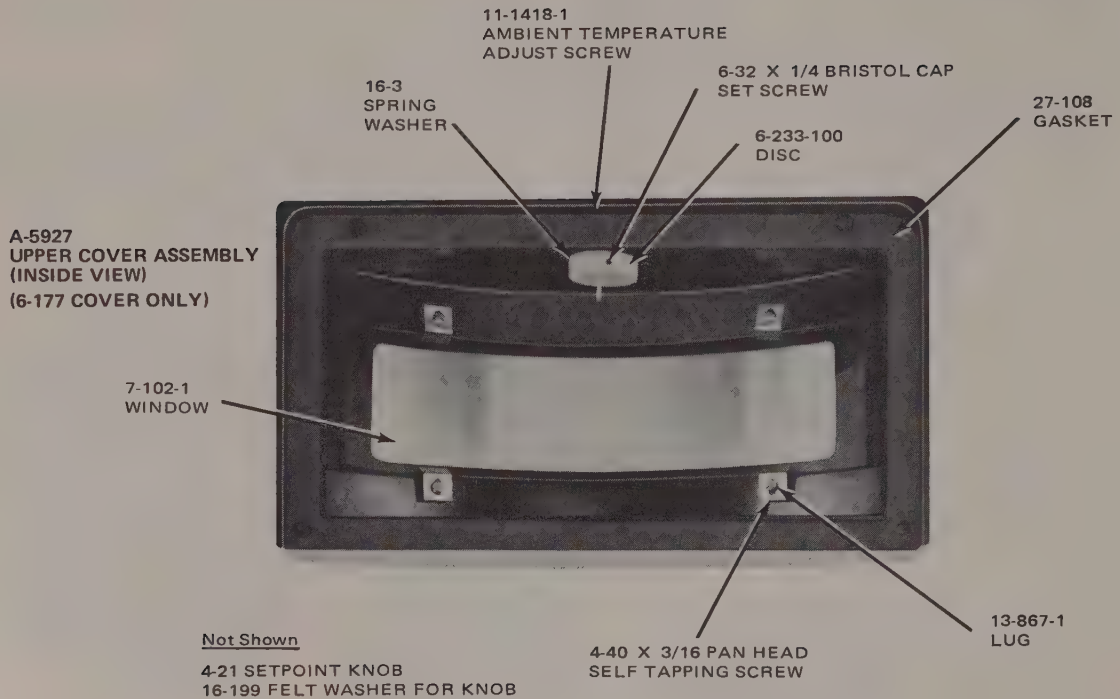


Table 1. Complete Assemblies

Model Number	Chassis Assembly	Lower Cover Assembly	Nameplate	*Indicator Assembly	Indicator Only	Complete Model Less Chassis & Lower Cover	Complete Model Less Chassis Only
471P-0	A-5998-1	A-6145	20-413	A-6175	470X-0	470B-0	471A-0
472P-0	A-6015-1	A-6146	20-414	A-6175			472A-0
473A	A-6566-1	A-6147	20-415	A-6175-100	473X-0	473B-0	473W-0
473A-1	A-6568-1	A-6147	20-415	A-6175-100			
473A-2	A-6567-1	A-6147	20-415	A-6175-100	473X-4	473B-4	473W-4
473A-3	A-6650-1	A-6147	20-415	A-6175-100			
473A-4	A-6566-101	A-6147	20-415	A-6175-200			
473A-5	A-6567-101	A-6147	20-415	A-6175-200			
473A-6	A-6567-201	A-6147	20-415	A-6175-200			
473A-7	A-6651-1	A-6147	20-415	A-6175-200			
475P-0	A-6023	A-6151	20-417	A-6175	470X-0	470B-0	475A-0
477P	A-6003-1	A-6152	20-418	A-6175			477A-0
480P	A-6446-1	A-6155	20-419	A-6175			480A-0
481L	A-6004-1	A-6157	20-420	A-6175-300	481X-0	481B-0	481A-0
481L-1	A-7561	A-6157	20-1090	A-6175-300			
487A	A-6796-1	A-6797-1	20-503-1	A-5168	487X-0	--	--

* The numbers in this column are for reference only. Use the next column to order an Indicator Assembly.

Note: Insert Code number for range and sensing unit in place of dots (. . .)



Complete Housing Assemblies Input

A-6462-100 K,J,E,T,F (Thermocouples)

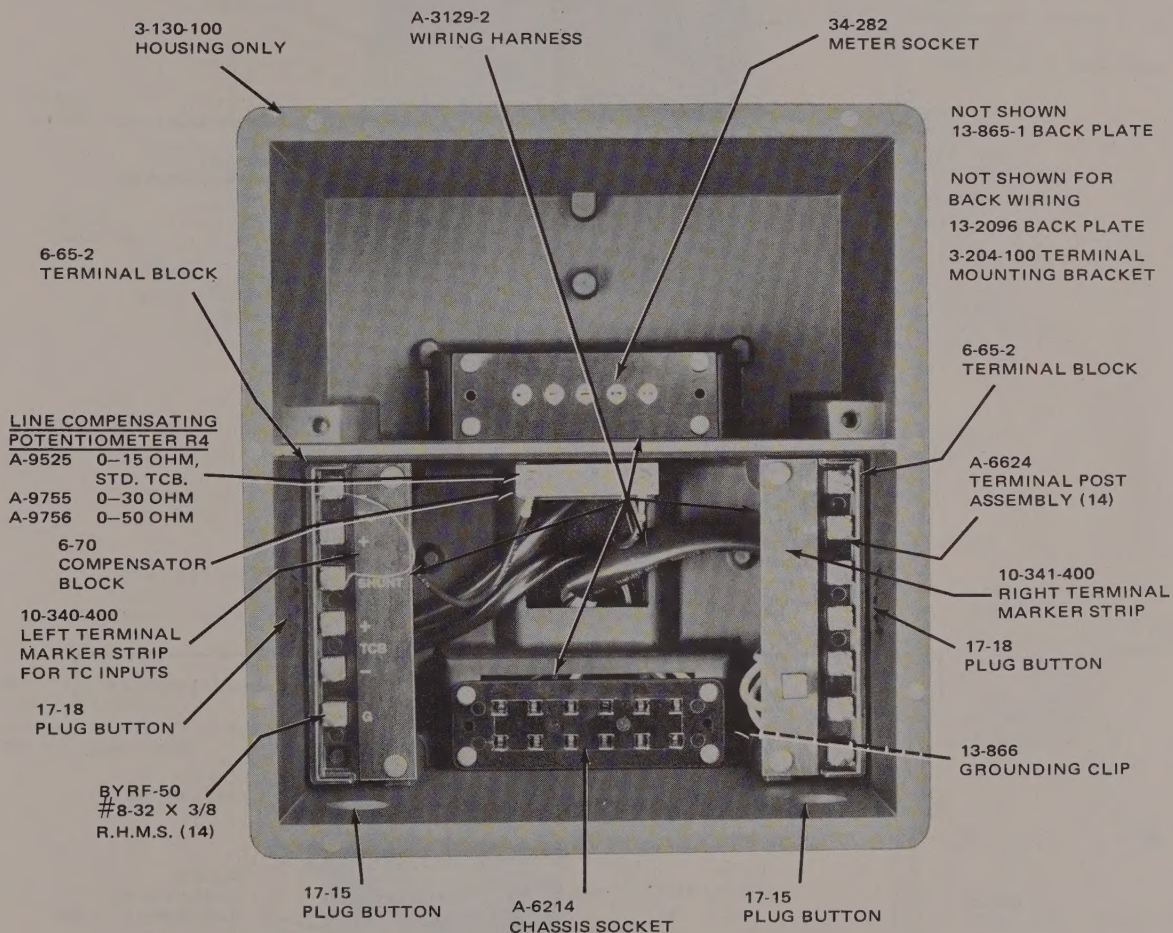
A-6462-200 S,R,C,G (Thermocouples)

A-6462-300 Indicating Pressure Millivolts
Milliampere
Zero Center Instrument
Transducer
RTD

Land Pyrometer

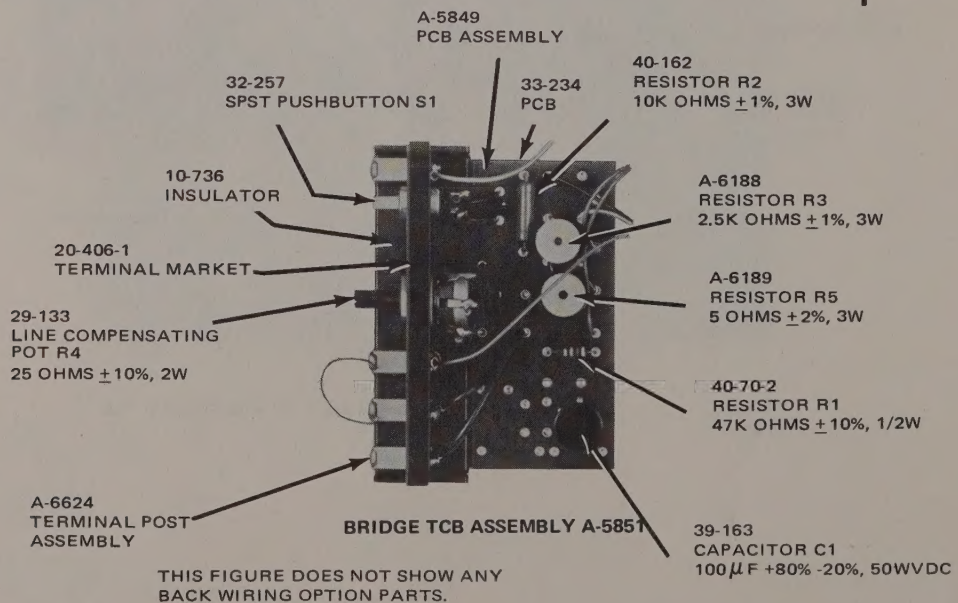
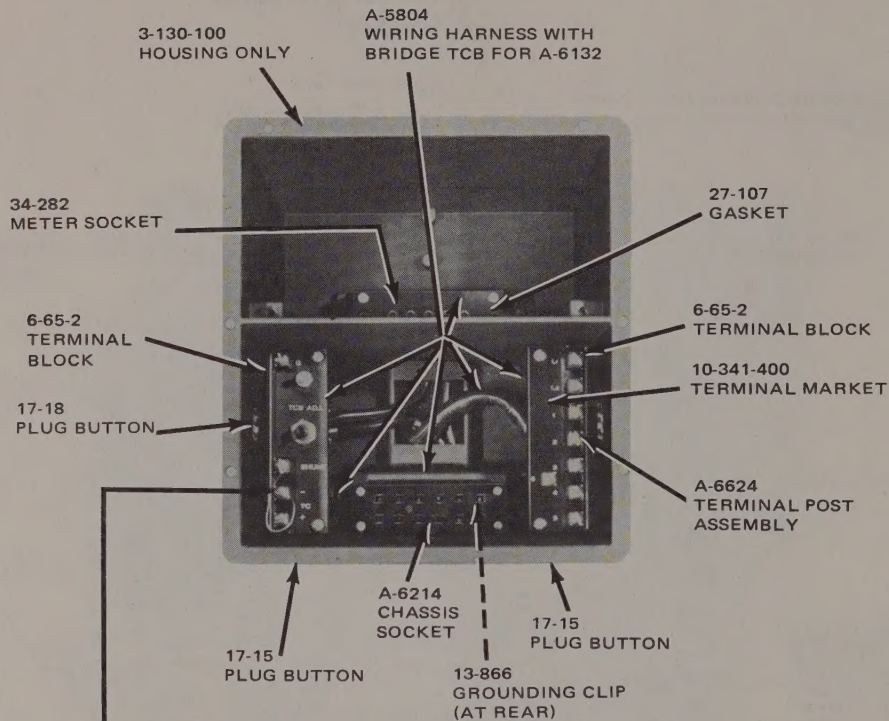
Type B Thermocouple

THIS FIGURE DOES NOT SHOW ANY
BACK WIRING OPTION PARTS.

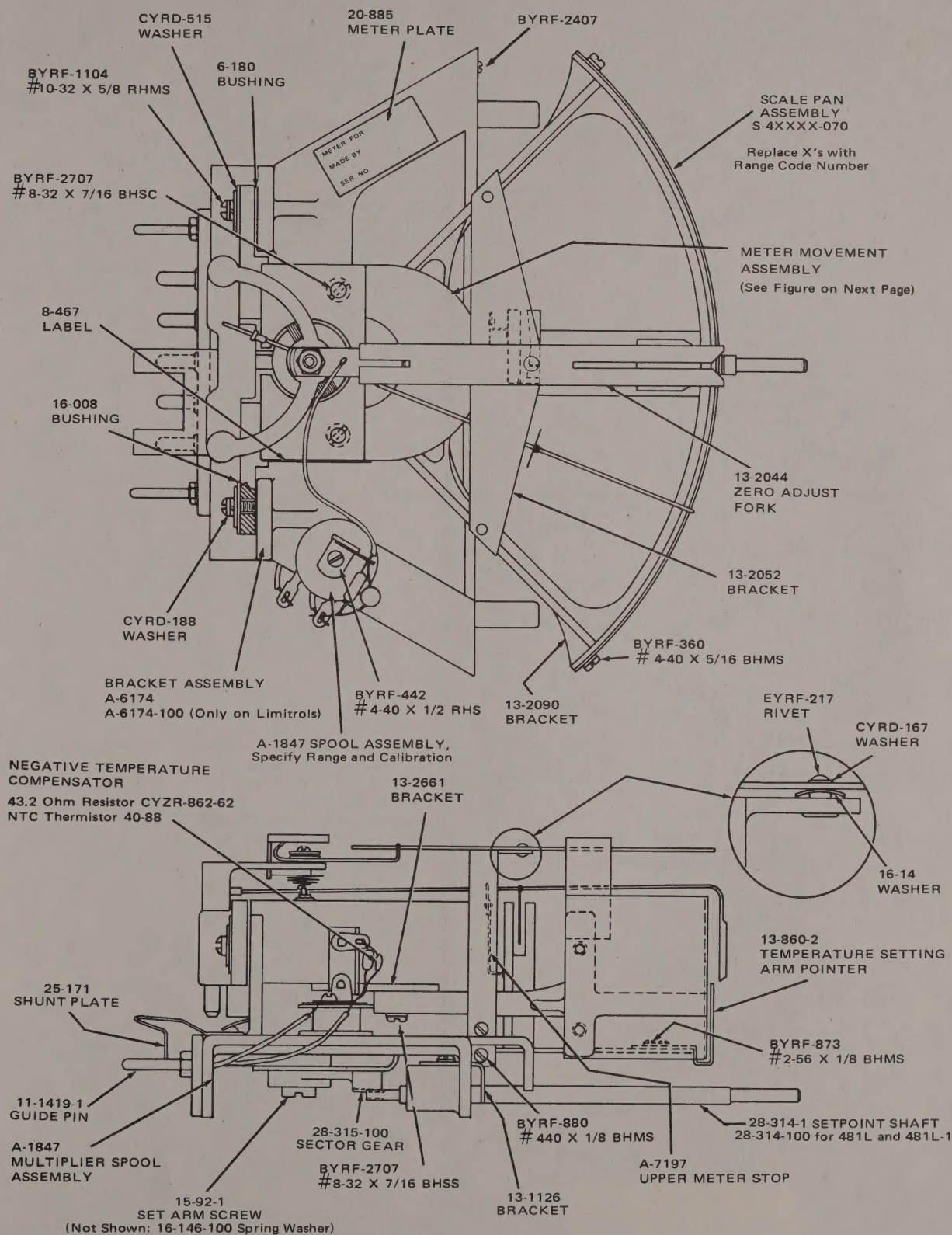


Replaceable Parts, Housing Assembly with Standard TCB

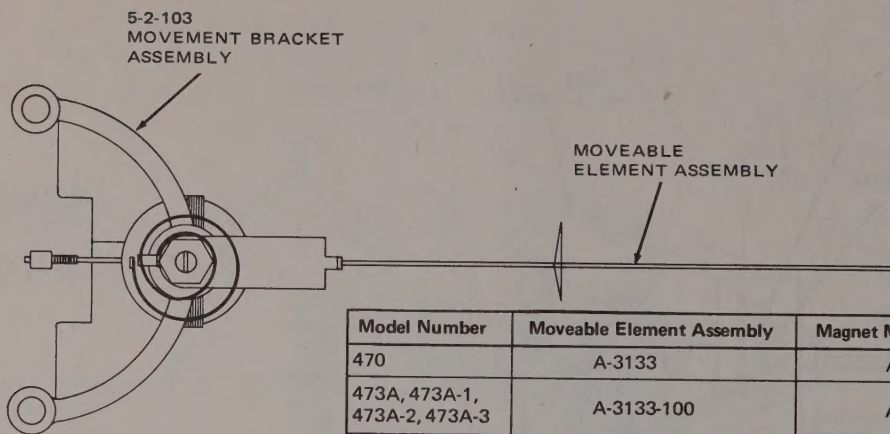
Complete Housing Assemblies
Models 481L and 481L-1 Only: A-7387
All Other Models: A-6176



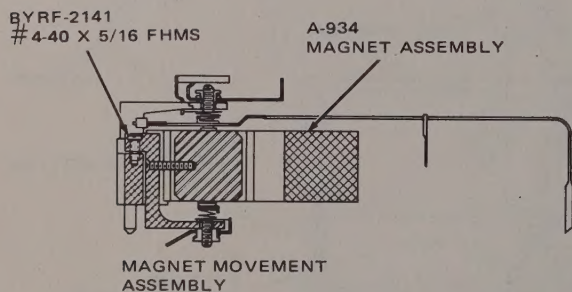
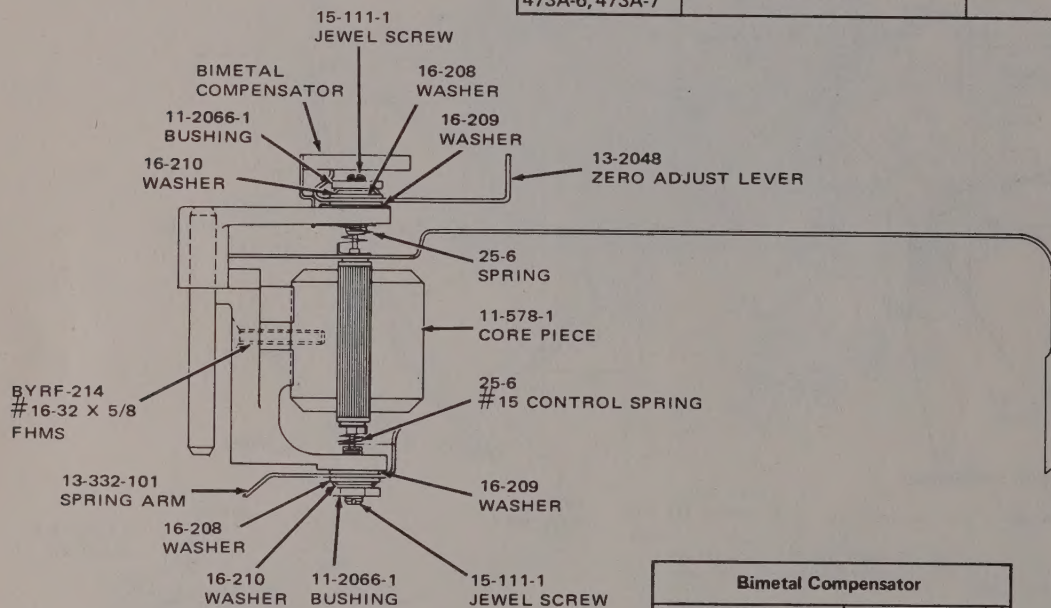
Replaceable Parts, Housing Assembly with Bridge Type TCB



Replaceable Parts, Indicator Assembly



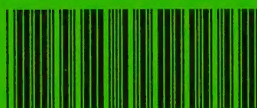
Model Number	Moveable Element Assembly	Magnet Movement Assembly
470	A-3133	A-6006
473A, 473A-1, 473A-2, 473A-3	A-3133-100	A-6006-100
473A-4, 473A-5, 473A-6, 473A-7	A-3133-200	A-6006-200



Bimetal Compensator	
Degrees Compensated For	Part Number
1.5	18-32
2	18-33
3	18-34
4	18-35
5	18-36
6	18-37
7	18-38
8	18-39
9	18-40
10	18-41
11	18-42
12	18-43
13	18-44

Replaceable Parts, Meter Movement Assembly

MP MASTER



MA32051

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